POWER

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Bonus and Penalty

Performance guarantees, and bonus and penalty clauses to safeguard them, are a stubborn old stumbling block in the contractual relationship.

Purchasers frequently feel the urge to require a penalty if the efficiency of a power plant, let us say, or some of its machinery, falls more than a certain amount below the guaranty. They shy, however, at the thought of paying a bonus for a better efficiency than offered by the builder, on the ground that such a plan would surely encourage the latter to fix his efficiency low enough to assure the earning of a neat additional sum. Yet, a contract with a penalty clause and no offsetting bonus is of doubtful legality and seldom acceptable to the seller.

Hence the deadlock!

Now there is a way to take this hurdle with safety to both participants.

The purchaser should fix an efficiency economically satisfactory to himself and reasonably attainable with the type of machinery desired. He should frankly state this figure, in the specifications, as the one below which penalty will be claimed and above which bonus will be paid.

There can be no doubt that the seller is entitled to a share of the increased earnings from a better built job.

Moreover the buyer will secure the desired protection against poor performance that the fixed minimal efficiency affords.

EDITORIALS

Industry Receptive to Welding Code

Born last July, child of much tribulation, the A.S.M.E. code for welded pressure vessels is now smiled upon by those most directly concerned with its rulings. To be more specific, the code has gained wide acceptance, both moral and physical, particularly by the larger manufacturers of boiler drums and other severe-service pressure vessels. These structures, it will be recalled, are grouped under Class I of the code and are required to undergo stress relief by heating of the entire vessel. In addition X-Ray films must be made of the entire weld.

These requirements, which were the cause of long argument before the adoption of the code, are now gracefully accepted by many of the manufacturers concerned. Both of these requirements involve substantial investments in stress-relieving furnaces and X-Ray equipment in addition to very appreciable operating expenses. Yet at least eight large manufacturers are now operating stress-relieving furnaces. Practically all of this group are using the X-Ray equipment.

On the other hand, various individuals in the fields of pressure-vessel manufacture have pointed to an economic danger—that overcautious engineers burden owners and users with the cost of stress relief and X-Ray inspection where these are unnecessary. Aside from boiler drums, Class I vessels are a highly restricted group. The great majority of pressure vessels used in industry will fall outside. In the long run nothing will be gained by exceeding code requirements.

Operators Must Face New Conditions

In general, the operating engineer has been less affected by the depression than the professional engineer. He may have suffered a reduction in compensation, but as long as the plant is kept running his services are required. However, he must not let this fact lull him into a false sense of security, for the period of recovery is certain to see management expecting more of the power department. Costs, wastes and operating procedure will be scrutinized as never before.

Many of the technical engineers who have been released from large engineering firms during the past year are likely to find employment with industrials in a supervisory capacity. Bringing to such work a breadth of experience and training, they may be expected to set up certain standards of performance which the operating man will be required to meet. If he has been on his toes, taking advantage of the present period to survey all possible plant improvements, delving into costs, and preparing himself for the new conditions, he need have no anxiety. Failing this, he will be a vulnerable target for central-station competition or will have to step aside for one better qualified to carry on.

Shifting Tonnages Affect Coal Market

The cooperative study now being carried out by the Bureau of Mines and the Brookings Institution on the flow of coal from mine to market is of considerable present value to the utility or industrial which uses fuel as a source of power. Such information as the volume of coal entering a particular market, and the sources of its origin, the shift from year to year in both volume and source, and the competitive relation of the various fields with respect to that market are all factors affecting fuel selection.

Analysis of the flow of coal from the low-volatile district of central Pennsylvania indicates a concentration of the production from this district in the industrial market of the Middle Eastern Seaboard and at tidewater. On the other hand, coal from similar low-volatile districts is more widely marketed. The same limiting peculiarities are apparent in coal distribution from the high-volatile districts. Analysis of the distribution, factors in relation to railroads serving the various fields, and tariffs applying to various markets, partly explains this spottiness.

More important, perhaps, are the shifts, both in volume and source, of the coals reaching the various markets. Coals from some of the producing fields expand into new markets and drop out of others. Tonnages increase and decrease with the changing economic factors that regulate their flow. While the data have not been collected for a sufficient period to prophesy trends, the continuation of their collection may yet make this possible.

Information on the flow of coal to markets is thus a valuable help by which the coal user may adjudge his purchasing conditions. When correlated with volumes and prices of such competitive fuels as natural gas and oil in individual markets, it becomes an extremely valuable aid to the whole question of fuel selection.

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POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

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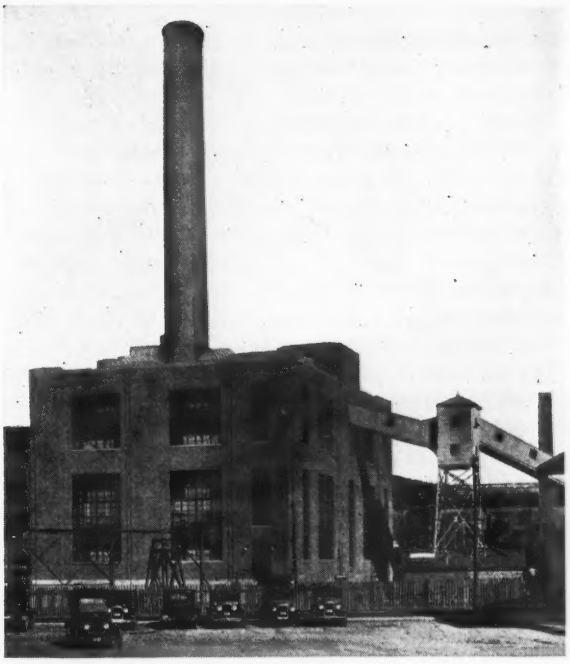

New boiler plant now contains two 12,059-sq.ft. boilers and at present operates to take the swings of the process steam load

By GEORGE H. DYER
Power Supervisor
Oxford Paper Company

Oxford Paper Company's

New Boiler Plant Operates at 85 Per Cent Efficiency

Two new boilers each designed for 165,000 lb. per hr. steam-generating capacity and 450 lb. pressure, to provide for future power generation, are now operated at 150 lb. in parallel with an old boiler plant. Factors that influenced the design of the plant and experience with its operation are given

THE Oxford Paper Company's mill in Rumford, Me., comprises a plant for making fine papers, both coated and uncoated. Manufacturing processes include those from wood room through soda and sulphite pulp mills to the finished product, and the uses of steam and power are those generally found in a complete paper-making plant. The mill is an extensive one and the requirements for steam and power are proportionately large.

All electricity is furnished by a hydro development generating at 13,000 volts. Several non-condensing engines and pumps are operated, and until the completion of the new boiler plant early last year all steam, excepting a small amount from an electric boiler, was supplied from one boiler plant with eighteen 5,550-sq.ft., multiple-retort, stoker-fired, Stirling boilers equipped with cast-iron economizers.

In December, 1929, the management, anticipating the replacement of the older boilers, decided to determine what benefits a new boiler plant could offer. Before the financial or other advantages of a new plant could be appraised, it was necessary to decide on the location for a new plant; the capacity of steam generating units for installation in the new plant; the fuel-burning efficiency for which the new plant should be built; the method of firing; and the steam pressure for which the plant should be built. A summary of the decisions on these points and the principal reasons for them will assist in understanding the plant.

Two locations for the plant were proposed, one being the site of the existing boiler plant and the other a vacant area several hundred feet away. Favorable impressions of the existing plant site were formed from general observations and its proximity to the load center and to the coal-handling plant, but a study comparing the two locations disclosed several decided disadvantages in the old boiler plant site, namely:

1. Although the new equipment could be installed on the area, the building width would be so limited that desirable clearances could not be had.
2. Construction costs would be at least $75,000 more than for the vacant area.
3. To remodel the old building and install new equipment with the old boilers in operation would lengthen the time of construction approximately twelve months.
4. The uncertainty of subsoil conditions from quicksand pockets would probably make the construction hazardous and more expensive than anticipated.
5. The potential value of the old boiler plant site for manufacturing space was much more than that of the vacant area.

The vacant area was chosen as the site for the new power plant.

Selection of the capacity and number of new boiler units involved consideration of steam loads, efficiency and serviceability of old boilers, reliability of steam supply and capital outlay necessary.

After carefully considering records of steam requirements, a plan was formulated whereby several of the boilers in the old plant would remain in service and the remainder of the steam requirements would be supplied from the new plant. The advantages of this plan were, deferment of part of investment for ultimate plant; abandonment of old plant when necessary; and future growth of steam requirements could be easily taken care of by installing additional units.

As a result of adopting this plan, two units each with a steam-generating capacity of 165,000 lb. per hour were selected. The lower efficiency of the old plant was compared with that of the new and it was found that installing an additional new unit, and shutting down the old plant entirely, would not save enough to justify the additional capital expenditure.

After careful consideration of costs it was found that sufficient heat-recovery equipment should be installed to give an over-all efficiency of 85 per cent. Any increased efficiency would not justify the increased cost.

The unit system of pulverized-coal firing appeared to better advantage than other methods of firing, when comparisons of necessary capital outlay and operating costs were made between different firing methods and when the location of the plant and the present and possible future fuel supply were given consideration.

The possibility of complete electrification of the mill, with the resulting increased power load, brought out the question of possible future power generation as a by-product of process-heat requirements. A decision on steam pressure was not advisable until investments and results with pressures of 150, 450, 750 and 1,400 lb. were estimated. With the 150-lb. plant, electricity for all purposes was to be bought from an outside source. With the higher-pressure plants the electricity was to be supplied from steam turbine-generator units acting as reducing valves between the boiler pressure and the lower pressure of about 150 lb. for process and mill supply.

The generating units were considered in two plans: (1) with non-condensing units only, and (2) with non-condensing and condensing units. Deficits in electricity supplied by the non-condensing machines were to be furnished by purchased electricity in one case and by the condensing units in the other. It was found that there would be a deficit of electricity from non-condensing machines at all steam pressures up to and including 1,400 lb. The economics of increased investment for higher pressure and the accompanying gain in power production showed pressures above 450 lb. to be unattractive and limited the plant selection to one for 150 lb. or to a 450-lb. plant.

Conditions precluded any generation of steam power to replace purchased electricity in the immediate future, a condition favorable to the 150-lb. plant and detracting from the potentialities in the higher-pressure job. However, ability to produce cheap power inherent in a 450-lb. plant—coupled with the uncertainties of future power demand and the practicability of a plant designed and built for 450-lb. ultimate pressure, operating at 150 lb. until a higher pressure is of use, when without change in the equipment the operating pressure can be raised—overcame the disadvantage of a larger capital outlay for the 450 lb. job, and it was selected.

Final authorization to proceed with this project was given on March 10, 1930. Plans and specifications were drawn up, material purchased and installed and the first unit was put in service Jan. 5, 1931. The second followed two days later.

The building, 93x118 ft. in plan, is a steel frame structure with red brick walls, concrete floors and roof and steel sash. The fundamental requirements for the building were suit-

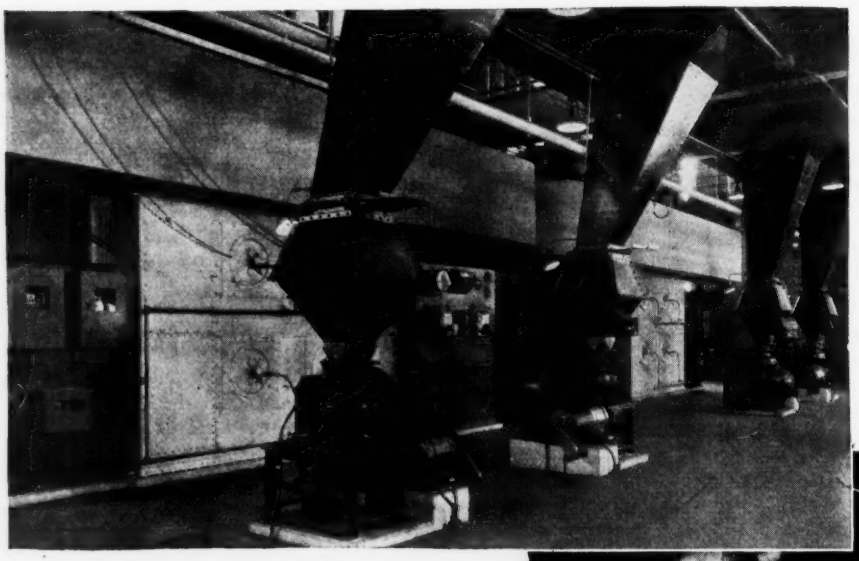

Fig. 1 — Operating floor, showing showing coal feeders, instrument boards and automatic combustion-control equipment

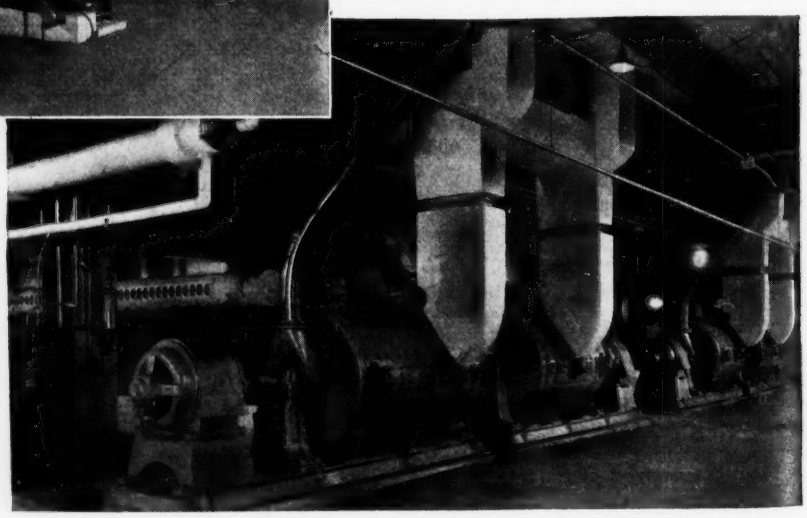

Fig. 2 — Two 5-ton-per-hour coal pulverizers for each boiler unit are installed on the ground floor. Each pulverizer feeds two burners, there being four burners per boiler

ability to its special purpose of housing steam-generating equipment and substantial construction with the minimum of expense for special architectural treatment of the exterior and interior to render a good appearance. It is placed on the lot so as to permit extension at each end, it being expected that a turbine room will be located at the southerly end and additional boilers, if the steam requirements demand, may be installed at the northerly end.

The old coal pocket and the crushing and handling building were retained. There are four trestles over the coal storage and the arrangement is such that all coal is put into storage from drop-bottom railroad cars on these trestles, and is reclaimed by one or the other of two conveyors operating in tunnels under the storage pile. The coal-handling building houses machinery for crushing and delivering the coal to a conveyor serving the old boiler plant and a 150-ton-per-hour inclined belt conveyor system discharging into a 1,000-ton steel-plate suspension bunker in the new plant.

There are two 5-ton-per-hour pulverizers for each boiler unit installed on the ground floor, Fig. 2. Table-type coal feeders direct coupled to variable-speed direct-current motors are located on the operating floor above each pulverizer, Fig. 1. Coal from the bunker feeds by gravity to coal scales, one for each pulverizer, and is discharged to the feeder hoppers and through the feeders to the mills. The construction of the bunker, gates, scales, feeders and connecting chutes incloses the coal throughout its travel and prevents dust and dirt.

Each pulverizer feeds two burners, there being four burners per boiler. The cross-sectional view, Fig. 6, shows the general relation of boiler and burners. The furnace, except the refractory burner wall, is water-cooled. The side-wall tubes bend inward toward the centerline of the unit to form a "V" bottom. These tubes are armored on the hearth. The setting above the water walls is solid refractory, except the front arch, which is water-cooled.

Beneath the V-shaped hearth there is a refractory lined cast-iron ash hopper from which ash is sluiced to a sump and pumped from it. Boiler, economizer, flue and chimney dust are cleaned into this sump with a hydro-evactor system.

General Arrangement of Equipment

An inspection of Fig. 6 will show the general arrangement of the equipment. The economizers are at the operating-floor level behind the boiler with airheaters above and with forced- and induced-draft fans at the upper level. The induced-draft fans discharge, through flues over the roof, to a red radial-brick chimney on the roof. The forced-draft fans take air from the top of the building and discharge downward through the air-heaters to the burner boxes. Preheated air is supplied to the pulverizers through branch ducts.

All auxiliaries, except the fans, are in a bay at the southerly end of the building. In this bay, on the ground floor, are the service, back-wash, sluice and chemical pumps. On the operating-floor level are the boiler-feed pumps, motor-generator sets and office. Filters and feed-water storage tank are on the next level, and on the upper level there is the feed-water heater and also the distribution switchboard for electricity supply to motor-driven auxiliaries. Steam-turbine drive is used for the feed pumps and forced-draft fans. The other auxiliaries and the pulverizers are motor-driven. All motors 20-hp. and larger operate on 2,300 volts, and smaller sizes on 600 volts. This selection of voltage conforms to the standard previously established for use with the mill motors.

Boiler-feed water is a mixture of about one part filtered river make-up and two parts condensate from processes and space heating. In the feed system of the old boiler plant all returns were brought to an open feed-water heater to which the make-up was added. This heater

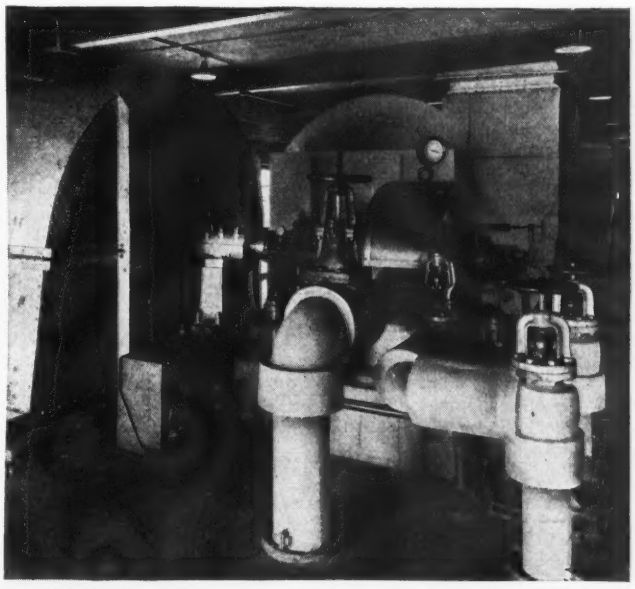

Fig. 3—Each of the two forced-draft fans is driven by a 150-hp., 4,030-r.p.m. steam turbine through reduction gears

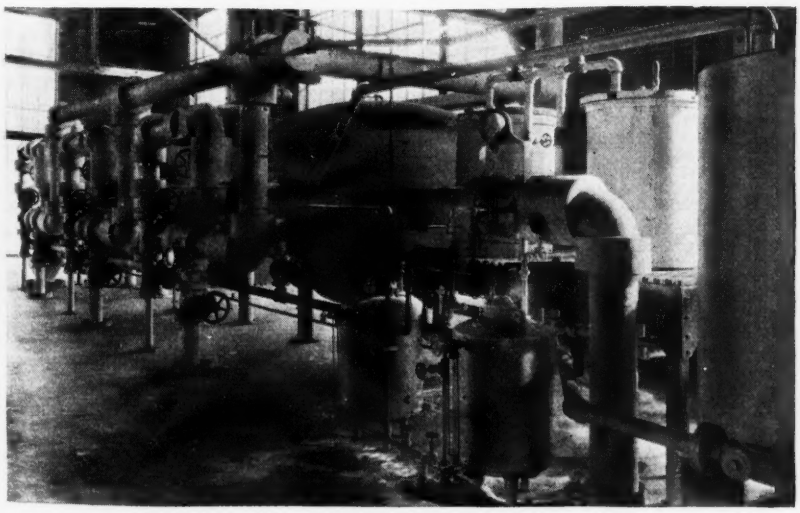

Fig. 4—Condensate containing oil is returned separate from the clean condensate and treated with caustic soda and aluminum sulphate and then filtered in the pressure-type sand filters shown in the photograph

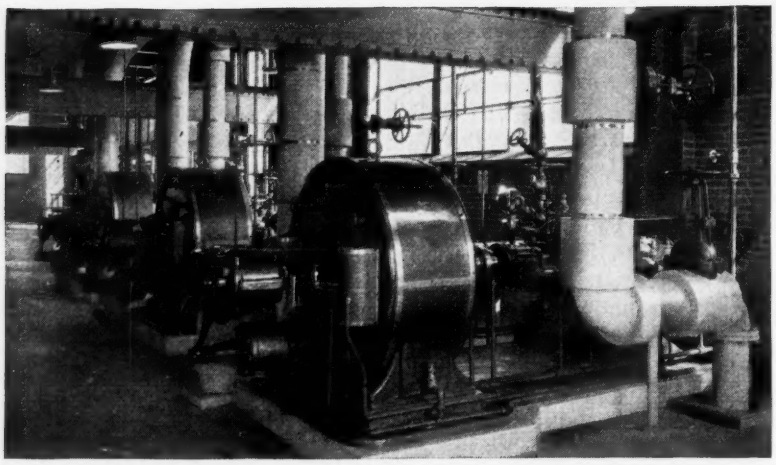

Fig. 5—The three boiler-feed pumps, rated at 530 g.p.m., 250 deg. F. water against a 1,375-ft. head are each driven by a 335-hp., 2,940-r.p.m. steam turbine

was supplied with exhaust from engines and pumps. A considerable portion of the returned condensate contained oil. With the new boiler surfaces to work at an average of 14,000 B.t.u. per square foot per hour, and the water-wall surfaces at a considerably higher rate, the presence of oil in the feed water was intolerable. It was therefore necessary to modify the return system to preclude the entrance of oil into the new boilers. Fortunately all oily returns were brought back to the old heater in one set of lines and the oil-free returns came back in a separate set of lines.

The old system was corrected to separate the oily returns from the clean returns and make-up, by discharging the oily returns into a flash tank, from which the flashed steam was piped to the old heater. Oil was then taken out of the exhaust steam entering the old heater with a separator built especially for this purpose. Two sets of pumps were installed, one set to pump the clean condensate from the heater and the other to pump the oily condensate from the flash tank through separate lines to the new boiler plant. The oily condensate is treated by feeding caustic soda and aluminum sulphate into the return line in the new plant and then filtering in pressure-type sand filters. The filtered water goes to the deaërating heater. The chemical treatment and filtering are cut into the return line between the flash tank pump and the new feed heater. The clean condensate is pumped directly from the old heater to the new one through its vent condenser.

The success of this arrangement depends primarily upon proper feeding of chemicals and the condition of the filters. To check these is a matter of routine, and the results have justified the plan adopted in place of using an expensive heat-exchanger installation and 100 per cent make-up, the alternative method for saving the heat in the returns.

The feed-piping system is arranged with connections, in the new boiler plant, to two other sources of supply for emergency use. The deaërating heater is fed with exhaust from the steam-driven auxiliaries and supplies water to the feed pumps with an oxygen content, checked daily, ranging from 0.02 to 0.03 c.c. per liter.

Feed-water treatment with soda ash and tri-sodium phosphate is applied under Hall Laboratories control. These chemicals are pumped intermittently, but regularly, into the feed pump suction header by a motor-driven pump operated with a time switch.

Troubles were encountered, as expected, after starting

IMPORTANT DATA ON THE PLANT'S EQUIPMENT

Proportions of Units and Plant

Ratio of economizer to boiler surface	1 to 4
Ratio of preheater to boiler surface	1.1 to 1
Cubic feet of furnace volume per sq.ft. of boiler-heating surface	0.83
B.t.u. liberation per cubic foot of furnace volume at 200,000 lb. steam per hour	25,000
Maximum continuous boiler rating, per cent	434
Square feet ground area per sq.ft. of boiler-heating surface	0.22

Principal Equipment

Boilers....Babcock & Wilcox Co., Stirling type, 12,069 sq.ft., 450 lb. maximum working pressure; 150 lb. present operating pressure.

Superheaters....Foster Wheeler Corp., convection type, 450 lb. and 635 deg. F. ultimate, present 140 lb. and 413 deg. F.

Water walls....Foster Wheeler Corp., 3½-in. No. 6 gage tubes. Rear wall, 338 sq.ft. wing-back surface. Side walls, 587 sq.ft. each, wing-back surface in vertical and Blizzard block on hopper. Front Arch, 420 sq.ft. wing-back surface.

Economizers....Foster Wheeler Corp., 3,024 sq.ft. in 2-in. diameter 14-ft. tubes.

Preheaters....Green Fuel Economizer Co., 13,220 sq. ft. tubular heaters in 2½-in. diameter 24-ft. tubes.

Pulverizers....Foster Wheeler Corp., 10,000 lb. per hr. Aero machines, motor-driven; two per boiler.

Burners....Peabody Engineering Corp., Toronto type; four per boiler.

Fans....Green Fuel Economizer Co., multivane, 58,800 c.f.m., 90 deg. F., 11 in. of water, forced-draft. Steel plate, 93,300 c.f.m., 350 deg. F., 12 in. water induced-draft with removable cast-iron liners in scroll.

Feed heater....Hoppes Mfg. Co., cylindrical, cast-iron, 500,000 lb. per hr., deaërating heater and 9 ft. 3 in. diameter × 25 ft. long Armo-Iron storage tank.

Filters....Cochrane Corp. conical, pressure filters with chemical feeding equipment, 550 g.p.m.

Boiler-feed pumps....Ingersoll-Rand Co., 4-stage centrifugal, 530 g.p.m. against 1,375-ft. head with 250-deg. F. water. Three units installed.

Ash handling....Allen-Sherman-Hoff Co., ash hoppers, sluiceways, ash pump and Hydrovac flue-dust removal equipment.

Coal handling....Stephens-Adamson Mfg. Co., 150 tons per hr., belt conveyors and tripper, corrugated-plate housing.

Auxiliary turbines....Terry Steam Turbine Co., two 150 hp. with reduction gears, 4,030 to 1,161 r.p.m. for forced-draft fans. Three 335 hp., 2,940 r.p.m. for feed pumps.

Motors....General Electric Co., two 300 hp., 600 r.p.m., slip-ring 2,300 volt for induced-draft fans. Miscellaneous motors, motor-generator set and 150-hp., 1,200-r.p.m. pulverizer motors.

Switchboards....Westinghouse Electric & Mfg. Co., 12-panel distribution board and 3-panel motor-generator board.

Miscellaneous Pumps....Ingersoll-Rand Co.
2 flash-tank, 415 g.p.m., 198 ft. head.
2 clean-condensate, 725 g.p.m., 190-ft. head.
1 ash-sluice, 1,500 g.p.m., 248-ft. head.
1 back-wash 1,000 g.p.m., 148-ft. head.
1 general-service 200 g.p.m., 150-ft. head.

Combustion control....Leeds & Northrup Co.

Piping....The M. W. Kellogg Co.

Chimney....The M. W. Kellogg Co.

Flue and plate work....Connery & Co.

Soot blowers....Diamond Power Specialty Corp. on boilers, superheaters, economizers and air preheaters.

Boiler settings....Frank E. Ross Co., solid refractory

Insulation....P. S. Thorsen Co.

Meters, gages and thermometers....Bailey Meter Co.; Brown Instrument Co.; Builders Iron Foundry; Ashton Valve Co.; Star Brass Mfg. Co.; Foxboro Co.; and Consolidated-Ashcroft-Hancock Co.

Feed-water regulators....Stets Co.

Electric wiring....York & Boothby

Building constructors....Morton C. Tuttle Co.

Consulting engineers....Chas. T. Main, Inc.

up. Although of a minor nature, being largely matters of adjustments, leaks, instrument troubles, etc., they were annoying, but no more so than is generally experienced in putting any new plant into opetration. Failures of equipment or faults requiring delays and major changes were not encountered.

To learn the characteristics of the equipment, in order to operate first reliably and then to best advantage for low steam-generation cost, was the real job. In the early period of operation, furnace pulsations were troublesome. Being particularly pronounced with light loads, the effective load range of the combustion-control apparatus was reduced and the pulsations were sufficient at all loads to interfere with the close adjustment of combustion by the control apparatus. Leakage into the furnace through the ash hopper doors was reduced by better sealing and fitting of these doors. This improved matters, and the final correction was made by installing a deflecting plate on the coal inlet of each burner.

Recently each steam-generating unit was taken down for a general inspection and cleaning, after evaporating between 35,000 and 40,000 lb. of water per square foot of boiler surface. The internal surfaces of boilers, water walls and economizers were so clean that it seems safe to say outage periods of the units will be determined by some element other than cleanliness of heating surfaces. No corrosion was in evidence and deposits in superheater tubes were absent.

Operating Results

As previously state, the new boilers are operated to take the swing of the load and the boilers of the old plant are carried at practically a constant load.

The limit of capacity of the new units has not been definitely established. Fusion point of the ash, moisture in the coal and fan capacity each may influence output under certain conditions. It has been demonstrated that 200,000 lb. of steam per hour can be generated and it is believed that this output can be maintained continuously with normal coal moisture and quality.

The performance guarantees of the equipment have been proved by a series of tests. Operating efficiency results since the period of final adjustments are showing better economy thermally and in the use of labor than were expected when figuring the savings. In other words, the plant is being operated closer to guarantee figures than was anticipated. For the past four months efficiency has been steadily increasing and has averaged

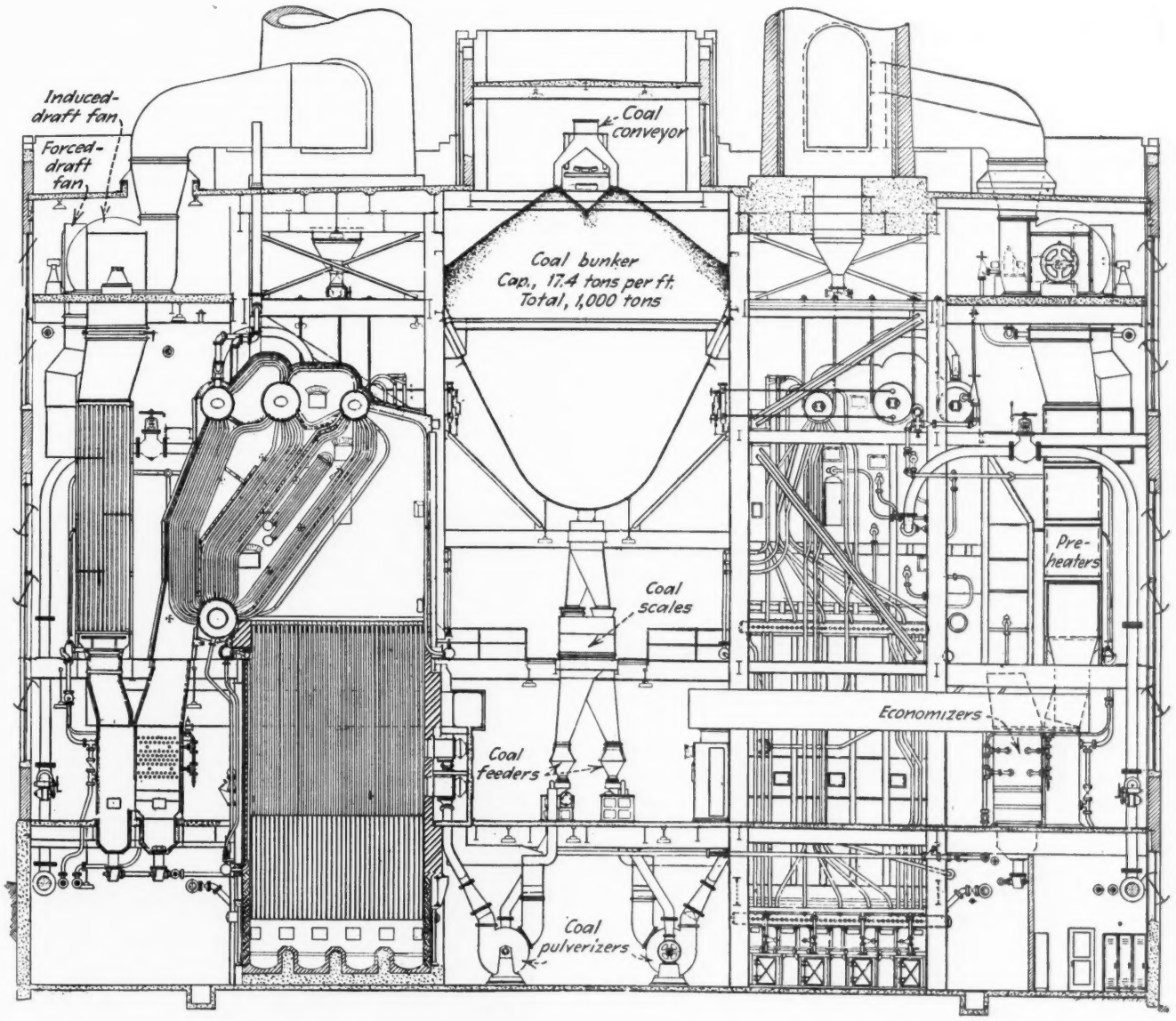

Fig. 6—The economizers are back of the boilers at the operating-floor level, with the air heaters above, and the forced-and induced-draft fans on the upper level

better than 85 per cent during this period. This figure is based upon the boiler room logs, which include daily coal analysis.

The project was carried out by Charles T. Main, Inc., of Boston. Mass., as consulting engineers working under the direction of F. J. Latham, chief engineer of the Oxford Paper Company, and the writer. All features of engineering design were decided by an engineering committee consisting of Marcus K. Bryan, representing Charles T. Main, Inc., and F. J. Latham and G. H. Dyer, representing the Oxford Paper Company. As a result of this procedure all decisions were unanimous and afterthought changes were eliminated. We recommend this procedure to other industrial companies as a solution of their engineering problems.

The Morton C. Tuttle Company of Boston was employed as building constructors and consultants in building design.

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Treatment of Motors For Operation in Wet Places

By MARIN PHILLIPS

Winding and insulation procedure applied to motors operating in wet places that eliminated winding failures where previously they frequently occurred

KEEPING water and moisture out of electric motor windings presents more or less of a problem for the maintenance man to solve, more especially so where the motors are operated in damp wet locations, such as paper mills and similar manufacturing plants. The motors in these plants are subjected to water dripping from overhead, leaky pump glands and splashing caused by tanks overflowing and a careless use of the hose when washing up floors. The latter cause can be controlled to a certain extent through proper training of the cleaners. This will not be entirely a success, because of cleaners being changed frequently. About the time one thinks that the cleaning crew is educated to the dangers of wetting electrical equipment a number of motors may be found wet. These uncontrollable factors make it necessary to so treat the motor windings that they will resist moisture.

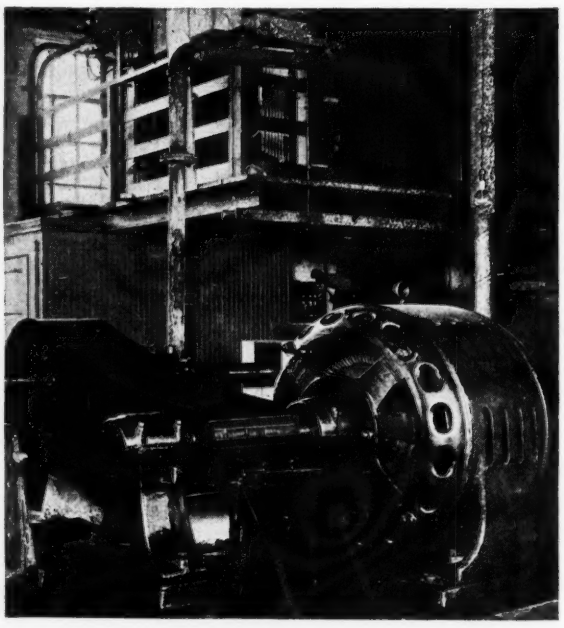
In one plant motor failures were occurring frequently from the absorption of moisture. The result was a high rewinding cost as well as some expensive delays in production. A careful study was made of how to treat the motor windings to make them more moisture-proof. As a result the following procedure was applied. How satisfactory this was in indicated by the fact that not a single motor came back far a rewind after the treatment was started, over a period of six years, during which the writer was in touch with the installation.

When a motor was brought into the shop for a rewind, the type of connection, coil pitch, size of wire and other winding data were taken while the stator was being stripped. Particular attention was paid to how tightly the wires fitted in the slots and if the slot insulation could be increased. Wherever the slot dimensions would permit, the coils were wound with double cotton-covered enameled magnet wire, the thickness of the slot insulation being governed by the motor's size and the amount of room in the slots. Generally the slot insulation cell consisted of one thickness of 0.012-in. or 0.016-in. fish-paper put in the slot next to the iron and reaching up to where the bottom of the slot wedge would be; one thickness of 0.015 in. empire cloth of the same size came next; then one thickness of 0.007 or 0.009 in. fish-paper inside the empire cloth. The last thickness of fish-paper extended $\frac{3}{4}$ in. above the top of the slots to protect the wires' insulation from damage while feeding them into the slot. A strip of fish-paper of the same thickness were placed between the bottom and top sides of the coils to insulate them from one another. The coils were taped with one layer of 0.010-in. cotton tape $\frac{1}{2}$ to 1 in. wide, depending on the size of the coils, lapped half-way. Where room permitted, a layer of cambric tape lapped one-half was first applied to the phase coils. To insulate the phase coils further and where coils crossed each other, two thicknesses of 0.015 in. empire cloth was placed between them.

When the motor was completely rewound it was given an insulation test of 1,100 volts to ground, with ten 110-volt lamps in series, for about one minute. It was then assembled and run for an hour or so to make sure that the connections were right and that there were no short-circuited coils.

The next treatment was to take the motor apart and place the stator in an oven having a temperature of about 75 deg. C. for four or five hours. This preheating is necessary if the dipping varnish is to penetrate the coils and slots properly. If the stator and coils are cold there will be a tendency for the varnish to chill and thicken, thus preventing it from reaching all parts of the coils and sealing up portions of the slots that the coils do not fill.

By means of a chain block the stator was lowered upside down into a tank of black elastic baking varnish until all of the coils were fully submerged in the varnish. The stator was allowed to remain in the varnish for about



A 250-hp. motor driving paper-mill beaters

two hours, or until all bubbling had ceased. This insures thorough penetration of the coils by forcing the air out of them. The stator was then raised out of the varnish and left hanging over the varnish tank until it stopped dripping. During this period the varnish tank should be kept covered with canvas or heavy paper having a hole in it for the dipping rope or chain to go through, to keep dirt out of the varnish. Keeping the varnish tank covered in this manner also helps to prevent evaporation of thinner, and helps the coils to drain more thoroughly, as the varnish is not chilled and thickened before it has a chance to drain off. The stator was then baked at a temperature of around 100 deg. C. for twelve to fifteen hours. All stators were dipped and baked three times, and for the final finish were given a brush coat of black quick air-drying, acid, oil- and moisture-proof paint.

This treatment is for motors with semi-closed slots, operating at 220-440 volts, having the coils taped after they are put in place. In the motors with open slots, having form-wound coils, which were taped before winding the stator, few failures occurred. When a failure did occur a new set of stator coils was purchased from the motor manufacturer. After the stator was rewound and all connections made, and tried for satisfactory operation, it was dipped and baked once to fill up the slots and insulate the end connections. In sealing the slots in this manner, in addition to excluding moisture, it prevents movement of the coils in the slots when starting the motor and movement due to vibration.

Coil movement will soon cause the insulation to fail in the slots, resulting in a grounded or burned out motor. Before dipping old motor windings in the baking varnish they should be thoroughly dried out and cleaned, to prevent contaminating the varnish with dirt, oil, grease, moisture, etc. For good results the varnish should be kept where its temperature will remain about right for dipping. This temperature is indicated by the manufacturer's recommendation for the specific gravity reading. This reading to be maintained by adding the required thinner as needed. The varnish must be stirred well before using, to mix the varnish and thinner thoroughly. Keep the varnish container airtight to prevent evaporation of the thinner and thickening of the varnish.

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Combination Burners Permit Profit From Fuel Competition

SIMILARITY in the combustion characteristics of pulverized coal, fuel oil and natural gas has made it possible to burn any or all of them in the same boiler furnace with relatively equal efficiencies. In plants now burning any one of these three fuels, provided the furnaces were originally designed to give adequate combustion volume and rapid mixing, a changeover to either of the other two fuels is merely a matter of adding the necessary equipment to prepare and distribute it to the boilers and the providing of burners for its proper firing. Combination coal, oil and gas burners, efficiently mixing and firing any one or all of the fuels, have been available for some time.

The construction of widespread pipe-line networks, in offering an economic means of connecting the vast quantities of hitherto wasted natural gas with potential markets, brought marked fuel economies to a large number of plants throughout the West and Southwest, whose furnace construction enabled them efficiently to utilize the new fuel.

Likewise the last decade has witnessed the discovery and development of what amounts to practically unlimited reserves of petroleum. The marketing of increased volumes of fuel oil, resulting in drastic reductions in delivered price, has placed oil in the position of offering definite fuel economies in consumer markets where coal has hitherto reigned supreme.

Thus by increased and more economical production and distribution the three basic fuels, coal, oil and gas, are progressively brought into wider and more active competition. This condition need in no sense be considered a temporary one. Estimates place the miles of existing natural-gas pipe lines in the United States at more than 65,000. Projects calling for the construction of about 10,000 more miles of lines were announced last year. Gas at present available in several of the larger fields of the Mid-Continent district runs into cubic footage figures which make the interplanetary distances of the astronomers seem puny. Large known reserves are being developed. An estimate of forty years' available natural-gas supply at the existing rate of extraction may be considered conservative.

Nor need anything approximating a shortage in fuel oil be expected any time within the reasonable future. Attempts have recently been made by several of the larger producing states to regulate the price of petroleum crude by shutting down wells. A consistent propaganda has long been active having for its object the conservation of mineral resources for the generations yet to come. The existence underground, however, of vast supplies of oil seems to exert a tremendous economic pressure tending to force the oil out. Also, something akin to a vacuum is created by the attraction of consumer markets where an "honest dollar" may be turned. These two facts, in spite of the force and relative merits of regulation and the needs of future generations, can be relied upon to insure the "leakage" of sufficient fuel oil into the markets to make that fuel an active and progressively important factor in the economics of power production for years to come.

Bituminous coal, of course, is always with us. The coal industry has long been in difficulties. The effects of improved utilization, however, augumented by the present depression and by competition from the other basic fuels have aggravated these perennial difficulties to the point where the concerted thought now applied to its problems by some of the country's best organizational minds should result in definite improvements in the industry's condition. Thus coal will remain actively fighting for its position as the principal energy source.

Whatever the final outcome of this active and growing competition between the fuels, the results should be beneficial so far as steam producers are concerned. Lower fuel prices for all three should result as the competition spreads, as well as better utilization methods as they become available to a greater number of plants.

In the meantime the plant so equipped as to utilize economically all three basic fuels is in a position to take ready advantage of even temporary reductions in the local market price of any one of them. The responsible heads of plants not so equipped but located in sections where such competition is now active or shortly will be, should certainly study the economics of so widening their plants' flexibility of fuel usage.

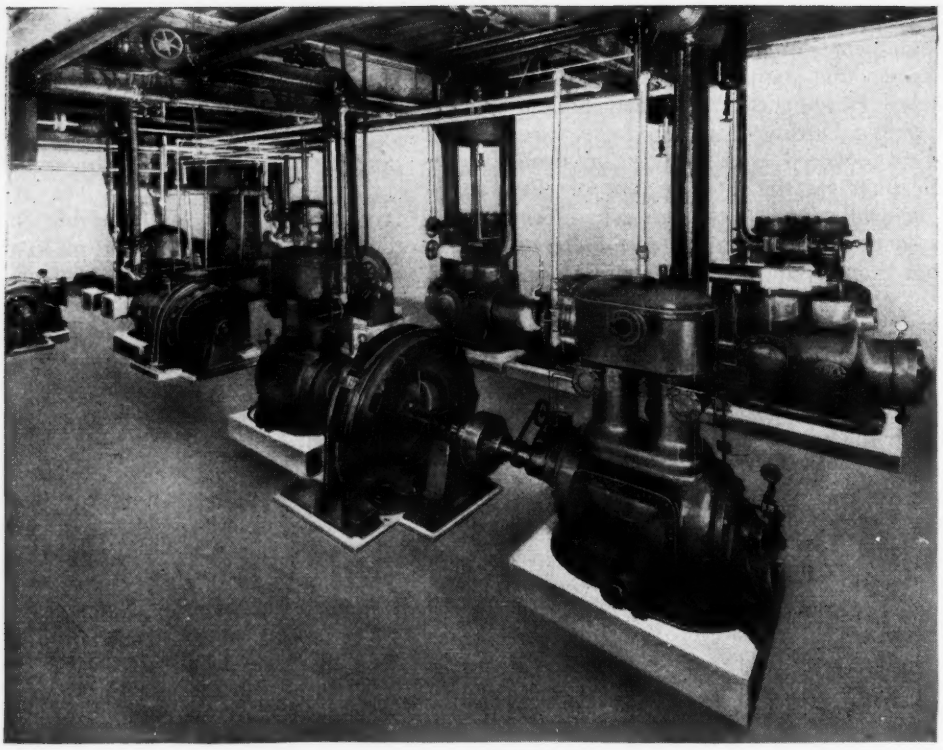


Fig. 1—Plant of the Massachusetts Ice & Cold Storage Company, where a split stage system is installed

Advantages of CO_2-Ammonia System For Low-Temperature Refrigeration

By W. R. KITZMILLER
Engineering Division
Frick Company, Waynesboro, Pa.

The production of low temperatures, economically, has become a topic of intense interest to the refrigeration industry, especially since the advent of quick-frozen foods. Of the various methods tried, the split-stage system has attracted most attention. This system has played an important rôle in the freezing and preservation of fruits, meats, ice creams, fish and other foods, and is being extended into other fields, such as process work in refineries, research work in laboratories and experimental work in industrial plants

ANYONE familiar with carbon dioxide knows that it evaporates at extremely low temperatures at suction pressures much above atmospheric. This characteristic led to the application of CO_2 to refrigerating purposes at low temperatures, but the extremely high condensing pressures usually encountered discouraged the adoption of either the straight or the compound CO_2 compression systems for low-temperature quick freezing plants. It was then discovered that evaporating ammonia to condense the CO_2 gas made the operation more feasible. Naturally the low head pressures under which the CO_2 operates in this type of system has encouraged still lower suction pressures, with lower compression ratios than are found in compound-compression plants employing this gas.

The split-stage system outlined in Fig. 2 operates as two distinct refrigeration systems. The low-pressure CO_2 gas is drawn into the CO_2 compressor and is discharged into the condensers, which are cooled by direct expansion of ammonia. The suction of the ammonia compressor removes the ammonia gas evaporated in cooling the CO_2 and discharges it into the usual ammonia high side. The ammonia liquid level in the CO_2 condensers is maintained by float control, thus insuring flooded conditions and a relatively low temperature difference between the CO_2 and the ammonia. This difference depends on the amount of surface, but can be maintained between 10 and 15 deg. F. with $8\frac{1}{2}$ sq.ft. of surface per ton of refrigeration when the equipment is properly designed.

The problem of keeping oil out of the CO_2 evaporator is important, since the oil congeals and rapidly lowers the efficiency of the cooler. Filters similar to that in Fig. 3 have been installed in the system to prevent any collection of oil in the evaporator. The filters are designed and located so that periodical cleaning can be accomplished with very little trouble and no shutdown. The same type of filters has been used successfully with plants producing solid carbon dioxide, where every trace of oil must be removed. The discharge gas is filtered through flake asbestos or hair felt. Occasionally a water-cooled separator is used to advantage; generally this is placed in series with the filter just described.

The construction of the CO_2 condensers is similar to that of the ordinary water-cooled condensers, except that, because ammonia is circulated in the tubes, heavier condenser heads are required. Usually the condenser shells are located along one side of the storage room common to such an installation, thus eliminating extra insulation. The ammonia load is approximately 25 per cent greater than the CO_2 evaporating load, and, in addition, provision must be made for any storage room load that can be carried on ammonia evaporation. Formerly the control on the liquid CO_2 line was a hand expansion valve, but lately automatic control of these systems has been considered with automatic expansion valves, float controls or magnetic valves. The use of motor-operated valves has also been recommended for high-pressure liquid lines.

The CO_2 evaporator can be used for cooling brine and air with either natural- or forced-draft circulation. Freezing systems vary in the application of the cooling medium and both air and brine have been used successfully. The most commonly encountered systems employ forced air for freezing fruits and ice creams, and brine for freezing fish and meats. The unwary buyer and inexperienced engineer are cautioned, in the selection of low-temperature evaporators, to be sure that plenty of surface is included. The fact is definitely established that the rate of heat transfer decreases rapidly as the temperature of the brine is lowered, and transfers between air and pipe should be figured low to eliminate disastrous results in case of severe frosting. The low transfers referred to are not restructed to the CO_2 system, for they are also common to ammonia evaporators.

In designing these plants, care must be taken to locate the evaporators and products to be frozen to best advantage. For example, when using air circulation a high velocity should be maintained over both the evaporator and the product, so that the best heat transfer may be obtained with a small rise in air temperature. Cold air entering the freezer should be in contact with the frozen products about to be removed, while the warmer air should be in contact with the warmer products just entering. Brine is often sprayed over the container to be frozen, although some systems use floating or submerged pans. Liberal circulation of brine hastens freezing and avoids high temperature rises, and also eliminates an increase of mean temperature difference in the evaporator, which would require a lower suction temperature. Ice cream-freezing equipment, fruit-freezing tunnels and fish-freezing equipment illustrate three distinct applications of the split-stage system.

In the split-stage cycle the most practical operating range for the ammonia suction has in most cases been found to be between 10 and 20 lb. This is the ammonia pressure on the CO_2 condenser and corresponds to a temperature range of —8 deg. to +5 deg. F., giving a CO_2 condensing pressure range of approximately 300 to 375 lb. The CO_2 evaporating temperatures and pressures naturally vary with the work to be done. Several systems have operated at from 80 to 85 lb. suction, corresponding to temperatures of —62 to —60 deg. F. Low temperatures similar to these are required in quick-freezing processes and in testing of insulators, engines, steel or other equipment subject to severe winter climates. Temperatures lower than those mentioned can be secured, but care must be taken to avoid "snowing" in the evaporator. Any-

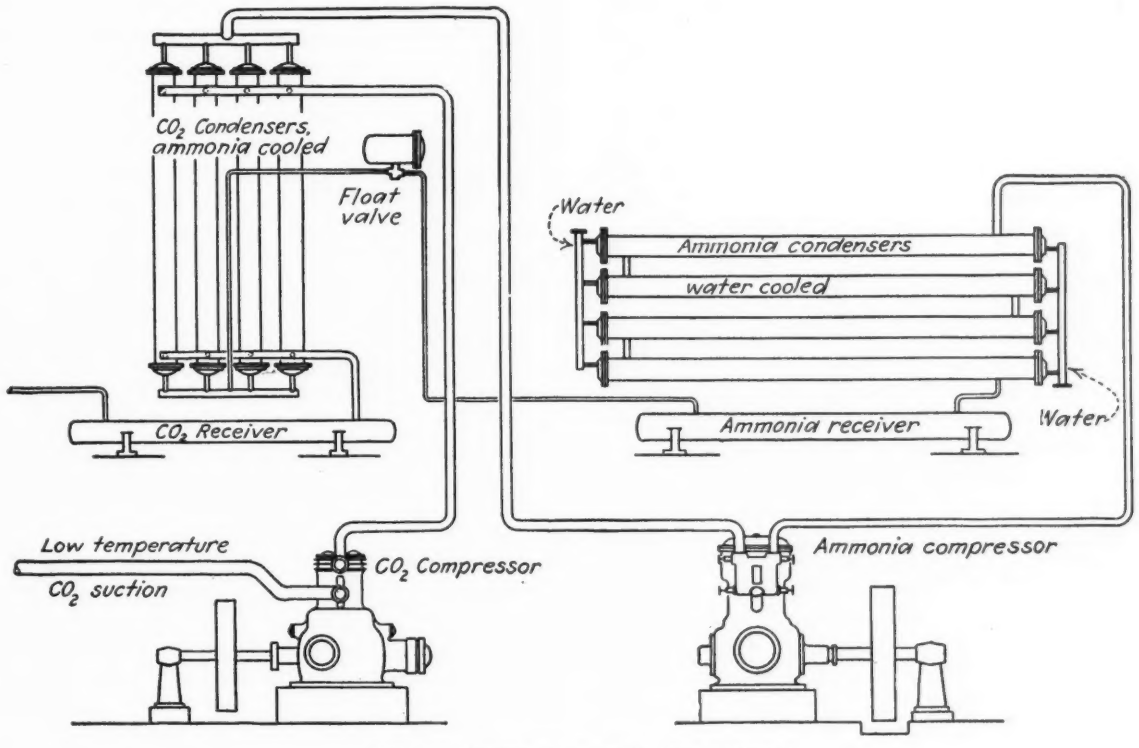


Fig. 2—Diagram of a split-stage system

one familiar with CO_2 is aware that from 60 to 65 lb. gage is the triple point where it is possible to have a liquid, gas or solid. Brine temperatures as low as —45 deg. or —50 deg. F. have been maintained without trouble from this source.

The CO_2-ammonia system has several other advantages over the compound CO_2 system. The low condensing pressure must be mentioned first, as this is one of the most important. High CO_2 pressures, such as 1,000 or 1,200 lb., are not impracticable, but they are uneconomical and inconvenient, resulting in loss of gas at times, especially when the water temperatures are high. The saving in power of the split-stage system must be considered an attraction. High-pressure equipment must be of a heavy design and very often of expensive material.

When using 70 to 75 deg. F. water, which is commonly encountered in the summer time, the split-stage system will operate on approximately 15 per cent less power than the compound CO_2 system. Often the ammonia system, in addition to condensing the CO_2 gas, is used for other cooling purposes. This offers flexibility not available with the CO_2 compound system. The intermediate pressure of CO_2 compound compression is often 350 lb. or more, corresponding to a temperature of 10 deg. or higher. This would not carry the low-temperature storages generally required for frozen goods. To decrease the ratio of low-stage compression would raise the horsepower per ton and consequently cut down the saving to be made over straight CO_2 compression.

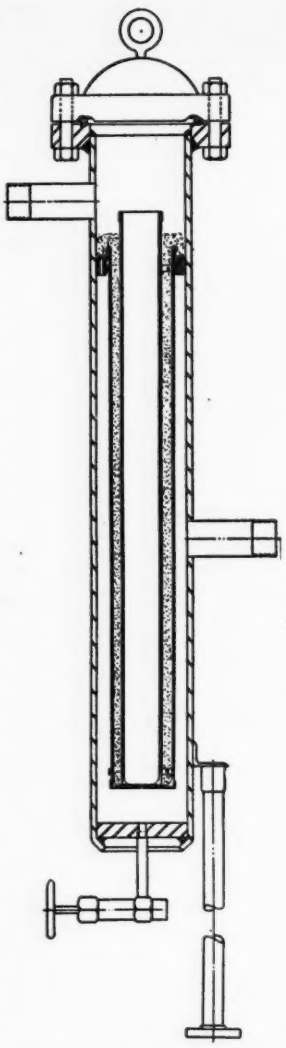


Fig. 3 — Oil separator used with CO_2

Some may wish to compare the split-stage system with booster-compound ammonia systems. In the latter system the ammonia low suction, operating at 15 to 20 in. vacuum, is compressed by a booster or low-pressure ammonia compressor up to 0 lb. or higher, then is raised by compound compressors to the condensing pressures. Theoretically, this system is advantageous and shows a small saving in power over the split-stage system; practically, it introduces complications similar but of a nature opposite to those of the CO_2 compound system. Operating under such a vacuum, it is obvious that leakage of air may be a problem, and unless stuffing boxes and joints are well guarded, the condensing pressure will rise, causing an increased power consumption. The split-stage system has no vacuum troubles, since it operates above atmospheric pressure. The condensing pressure of the CO_2 is not much above the ammonia condensing pressures encountered in tropical countries.

It has often occurred to the writer that split-stage quick-freezing plants could also manufacture the frozen CO_2 required for their shipments of goods. The power requirements per pound of frozen CO_2 for a split-stage system, is no more than that required by the ordinary frozen CO_2 plant. The only additional investment over the cost of the low-temperature freezing and cold-storage machinery would be for a CO_2 booster compressor, liquid coolers, intercoolers and snow machine. The frozen CO_2 could be manufactured as required, avoiding losses during storage and transportation. Of course the additional investment would be tied up in equipment used infrequently, but the cost of CO_2 would no doubt be the deciding issue. The help required to produce this frozen CO_2 would not exceed the usual manpower required around a quick-freezing plant where the CO_2 is not frozen.

Influencing Factors

The cost of CO_2 liquid, location of plant, cost of labor and power, kind of product and amount to be quickly frozen, amount of CO_2 ice to be made and size of storages and temperatures are factors that decide the economy of making CO_2 ice to use in shipments of the frozen products. The production requires approximately 10 hp. per pound per minute with the usual split-stage system based on receiving the CO_2 gas at a low pressure. This will be lowered nearly 20 per cent when receiving bottled liquid, which would furnish the usual make-up for the split-stage system. Power consumption would vary according to the requirements of any particular plant and depend to a great extent on the water available.

Automatic control for low-temperature rooms operating under the split-stage system gives a positive-pressure cycle. With ammonia working under a vacuum automatic apparatus is difficult to keep adjusted for continuous results. Pressure switches, for example, have been devised for vacuum operation and are usually sensitive, but their range of usefulness is limited. Temperature control can be used, but here again the operation must be carefully guarded lest the feed of ammonia become restricted too greatly and the compressor operate at too low a pressure, which would be uneconomical. Feeding too fast raises the pressure, with a corresponding rise in temperatures and the possibility of carrying liquid over to the compressor.

Automatic Control

The split-stage system operates under a pressure enabling magnetic valves, float controls, automatic expansion valves and pressure switches to give best results. The shafts of the CO_2 and ammonia compressors can be coupled together and driven by either a synchronous motor mounted on the shaft or by a belt wheel. An outboard bearing carries the weight of the wheel or motor and the coupling load. Since both machines are tied together, the starting of the motor places the entire system in operation.

The use of synchronous motors eliminates belt drives and provides more positive operation. When arranged with an unloader, both compressors come up to speed before being subjected to the load. After synchronous speed has been reached, both loads are gradually applied. This unloader works equally as well with hand starters, since a press on the "start" push button station unloads the machine and starts the motor, without the necessity of using the hand operated bypass valves. Synchronous motors generally provide the most economical drive, although high-torque squirrel-cage motors with V-belt drives give excellent results.

Induction Motors Replace Steam Drive on Two Derricks

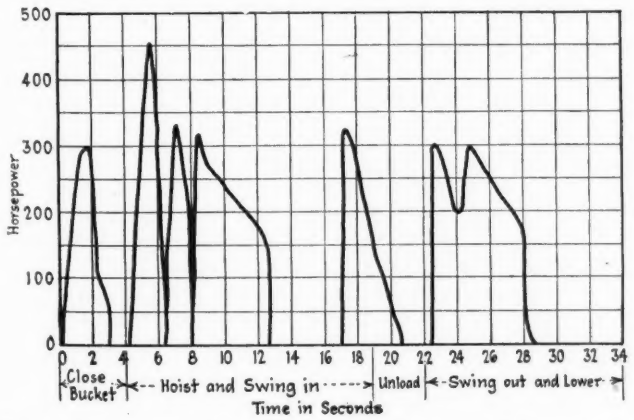
By R. F. EMERSON*

IT BECAME desirable to change two steam operated derricks equipped with orange-peel buckets and used for handling ashes and refuse, for electrical operation. When changed from steam it was important that the electric drive should not reduce the capacity of the equipment. Stop-watch observations showed that a round trip of the bucket could be made in 35 sec. counting from the time the operator started closing the bucket jaws on a load, raising this load and swinging it over the dump car, discharging the load and then returning the empty bucket to the barge for another load. Calculations were made as to the power and time required to perform this complete cycle of operations, taking into consideration all friction losses and inertia loads as well as the weight of material handled.

It was estimated that a 300-hp. 600-r.p.m. motor could make a round trip as quickly as the steam engine, notwithstanding that the steam engine is inherently a livelier machine than an induction motor. The inertia of the rotor of the motor was found to be a considerable part of the total inertia of all the moving parts. Another advantage of the steam engine was, the operator could crack the throttle slightly and allow a little steam to enter the cylinders. This would allow an empty bucket to lower very slowly and rest gently on the side of a car and tilt it to a level position. Occasionally the train crew had difficulty in hooking a car after the dumping operation and the fine speed control obtainable with the steam engine enabled the bucket operator to assist in doing this when necessary. It was desired to be able to accomplish the same result with the proposed electrical rig, although it is well known that speed control at speeds below synchronous with an overhauling load is impossible to obtain with an induction motor.

For operating the 300-hp. motor, full-magnetic control with a 6-point master switch was used. The motor was equipped with a standard solenoid brake. So far as the operator was concerned, he operated with the new arrangement practically the same as with the steam rig except that he had a master switch handle to operate instead of a steam throttle. For lowering a bucket slowly a foot operated push button was installed. Stepping on this button released the brake without putting power on the motor and allowed the empty bucket to overhaul the motor. Because of the inertia of the rotating parts, the bucket gathered headway slowly and it was possible to tilt a car exactly as well as with steam.

*Industrial Engineering Department General Electric Company.



Typical duty cycle showing power required to make one round trip with orange-peel bucket

The figure shows a typical duty cycle with horsepower plotted against seconds showing that a round trip can be accomplished with the electrical equipment in as short a time as with the steam. By actual test the kilowatt-hour consumption per round trip of the bucket was 15 per cent less than estimated. This is a fairly close estimate since an operator seldom operates the same each time he handles a load of material. Furthermore, different operators will handle the same rig differently due to varying degrees of skill and experience.

Although the steam rig was non-reversing, the electrical equipment was furnished for reversing service. This was of considerable assistance when worn-out cables were replaced with new ones. Formerly the old cables unwound from the drums by hand which required considerable muscular effort. With the reversing electrical control, it was only necessary to run the motor in the reverse direction and one man could walk away with the loose end of the cable.

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Maintaining Proper Liquid Level

By M. F. KNOY

IT GOES without saying that in a refrigeration plant sufficient liquid ammonia should be maintained in the receiver to seal completely the outlet that supplies the expansion valve. If this is not done high-pressure gas will blow through the expansion valve into the evaporator. It may be seen from the tables or a glance at the Mollier diagram that the total heat of a pound of saturated vapor at the head pressure is greater than that of a pound of saturated vapor at the suction pressure. Hence any high-pressure gas going into the evaporator performs no refrigeration whatever. It actually tends to give up rather than to absorb heat.

If in each 10 lb. of ammonia going to the evaporator there is 1 lb. of high-pressure gas, only 9 lb. of the ammonia will perform refrigeration. Yet compressor capacity and power requirements will be the same as if the entire 10 lb. of ammonia had been liquid. In other words, whatever the percentage of high-pressure gas in the ammonia going to the evaporator, refrigerating capacity will be decreased and power consumption increased by about the same proportion.

In view of this fact it is surprising that some engineers think that it is economical to delay charging the system as long as possible. If they wait until the effects of a broken seal are pronounced it is likely that an imperfect seal will have been crippling plant efficiency for some time. Some men have been known to delay charging even when the ammonia was already on hand and paid for. Rather than saving ammonia, such a practice results in greater losses, for when the seal in the receiver is not perfect the plant will have to operate more hours per day, thus increasing the amount of leakage on the high-pressure side of the system.

In other cases plants have been known to operate for months without a gage glass on the liquid receiver. This is another poor practice; it leaves the operator without any certain means of knowing when the liquid level falls low enough to break the seal partly.

Pulverizer Sizes and Installation Details From the Operator's Viewpoint

By C. F. HAWLEY*

In the last analysis, the operator's viewpoint should be that of the chief engineer, the designer, and the owner, because it is the operator who makes the installation either a success or causes it to be just another collection of equipment

THE ART of firing pulverized coal has passed through several stages to the place it holds today. First, the pioneer stage when a few engineers persistently overcame seemingly insurmountable obstacles. Then there was the credulous age when all one heard in combustion circles was how Mr. A. had operated at 400 per cent of rating and Mr. B. had installed pulverizers and saved 75 per cent of his coal bill the first month. Next, the technical era in which engineers discoursed long and eloquently on heat release, B.t.u. per square foot of heating surface, and so forth. Out of all this has come a fairly rational set of design formulas, until today the performance of any given set of combustion equipment can be closely foretold. We come now to what may be called the age of design with reference to the operator's views.

First consider that all-important question of reliability and continuity of service, for to the operating man nothing matters more than an arrangement of equipment whereby he can secure continuous service without danger of sleepless nights and sudden emergency calls.

Maximum Load Alone Insufficent

There are several ways by which, with the unit system of pulverized-coal firing, shutdown from the failure of any one unit can be avoided. In the first place, the load to be carried, that is, the maximum, normal, and minimum, should be carefully decided upon. Too many times while the negotiations for the purchase of equipment are under way the customer states only the maximum load that he desires, apparently interested only in securing the most capacity for his money rather than an operating assembly when he has finished. With the three load requirements in mind it is possible to pick combinations of pulverizers and burners which will give the most efficient results not only from the standpoint of boiler efficiency, but also on a dollars-and-cents basis. A few specific combinations of equipment will bring out the point. Consider the following requirements:

1. Plant with several boilers and a normal load of 75,000 lb. of steam per hour demanded from each boiler and no minimum load requirements.
2. Plant with two boilers and a normal load demand of 75,000 lb. of steam per hour from each during the day but a night load of 50,000 lb. each.
3. Plant with one boiler and a day load of 75,000 lb. of steam per hour during the day and a night load of 10,000 pounds.

For the purposes of this comparison it is assumed that an evaporation of about 10 lb. of steam per pound of coal is obtained and that each pulverizer is capable of an overload of at least 10 per cent. The term efficiency of operation as applied to pulverizers simply means that they operate at the lowest power per ton basis, which is encountered at or near their rated capacity.

For all three of these plants the same size pulverizer could serve so far as maximum load is concerned, and that is what the customer would be likely to buy unless his load requirements had been carefully analyzed. Now let us see what can be done with the plants for arrangement of equipment designed to give continuity of service and ease of operation.

For plant No. 1 the writer would recommend a pulverizer with a rated capacity of 7,500 lb. per hour. In this plant, with several boilers, economy would demand operation of the pulverizers at near capacity, as there are several boilers to pick up the load in case of trouble with any one unit.

For plant No. 2 the writer would recommend three pulverizers of 5,000 lb. per hour capacity each, the two end machines direct connected to their respective boilers and the middle machine connected to each. This allows the operation of all three machines during the day at an efficient rating. For the night load the middle machine is shut down and the others still operate at an efficient load, with the third machine as a spare unit. This combination also makes possible the generation of at least 110,000 to 120,000 lb. of steam in the event of failure of one pulverizer. Of course, if the generation of 150,000 lb. of steam at all times is a prime necessity the size of unit can be increased to 7,500 lb. This means lower pulverizer efficiency during the night operation.

For plant No. 3 two pulverizers, one of 5,000 lb.

*Engineering Dept. Riley Stoker Corp., Worcester, Mass.

capacity and one of 2,500 lb. capacity, would be desirable. During the day each machine would operate at an efficient point and at night the large machine could be shut down and still leave efficient loads for the small one. Another combination would be two pulverizers of 5,000 lb. each, which would give greater insurance on the heavy load but a corresponding penalty on the low load.

This question of small pulverizers for night and Sunday loads is one which should receive much more attention than it does, and although it appears to involve slightly greater investment, this would soon be offset by lower grinding costs per ton and ease of operation.

If first cost without any consideration of insurance against machine failure is the one thought, then one pulverizer per boiler may be applied to each of these cases. Care should be taken in the selection of the machine and burner to see that the combination will give the required range of operation. The burner should be one in which it is possible to shut off all the secondary and a large part of the primary air supply without injury to the burner or danger of burning back into the piping system.

After the selection of equipment to give maximum assurance of continuity of steam production, the arrangement of the equipment into an easily operated unit is of prime importance. For the first week or two of operation of any new equipment the operator will chase from one side of the boiler to the other faithfully moving coal feeds, air controls and dampers in the proper relation. Soon, however, he may be less careful and the efficiency will drop correspondingly. It becomes important therefore to have as few controls as possible and, together with the instruments, located at a central position.

In an ordinary industrial installation of unit pulverizers and forced-draft burners, it should be necessary to have only three main controls: namely, coal feed, either by speed or position of a scraper knife; secondary air to the burner, either by speed of fans or dampers; and furnace draft control, either by speed of fans or dampers. In one installation with which the writer is familiar a mechanically minded engineer brought all the controls for three boilers, together with the necessary instruments and starting equipment, to one board so that the operator does not have to move from this central location. Needless to say his ingenuity has been well repaid in increased efficiency. In central station practice this has long been the custom, but all too often in industrial work the equipment is bought and installed with less attention to the needs of the operator.

A few words might not be out of place here on the necessity for care in the selection of fan drives, especially with reference to induced-draft fans. Sometimes the fan drive is bought with only the top rating in mind and no attention is paid to proper design for the lower loads. It is essential in plants where a low load is at times encountered to have the fan control such that a low speed can be obtained, or, better yet, an arrangement whereby the fan can be bypassed and a direct connection to the stack for natural-draft operation be made. This also serves as a convenient form of insurance so that at least a part of the load can be carried in the event of fan failure. In one plant such a bypass was especially valuable and permitted load to be carried during the repair of the air heater and fans. It is also important that fan speed controls are such that there are no sudden jumps to tend to upset operation.

After the equipment has been selected and arranged for continuity and ease of operation another point remains which is sometimes given little attention. That is the arrangement whereby coal is fed to the pulverizer. Many an otherwise excellent installation has been marred by the installation of poorly adapted coal hoppers and other coal-feeding arrangements which have to be practically taken apart in case of coal stoppage. It has been proved by experience that hoppers with one straight side and the others sloped about thirty degrees from the vertical usually feed all manner of coal with the minimum of trouble. It has also been observed that there never was a coal pipe or hopper installed which was not improved by a cut-off gate at the bottom so that work on the feeder could be done without first dumping a ton or two of coal on the floor. Another point to bear in mind with respect to coal hoppers and pipes is that the operator should be able at all times to see and assist if necessary the coal on its way to the pulverizer. At times a desire for the utmost in cleanliness has led engineers to so conceal their coal-feeding mechanism that in case of coal stoppage it is necessary to dismantle it before the trouble can be corrected. This complicates the generator's problem.

Gas Pipe Lines in California

Commutator on Large Armature Trued in Temporary Bearings

By B. W. HAMILTON

MOST hydro-electric plants are situated some distance from the commercial center they supply with electrical energy. Due to this remoteness the plant engineers frequently have to resort to unique means to do certain pieces of work. It might interest readers to know how large commutators were trued without using a lathe.

Some time ago an electrical failure occurred in a duplex waterwheel-driven exciter set. This set consisted of two direct-current armatures pressed on one shaft and operated in a vertical position. This failure made it necessary to remove the rotor and rewind one armature. It was also necessary to dismantle the commutator and re-insulate between some of the bars that had been shorted. After the repair it was necessary to resurface the damaged commutator. Since the other commutator had been damaged slightly due to arcing, it was decided to resurface it also.

Inasmuch as this machine operated in a vertical position, it is readily seen that any cutting or grinding of the commutator done in its regular position would allow the metal shavings or copper dust to drop into the winding. The armatures' construction made them difficult to clean after dust had entered their windings, and it was decided that truing the commutators must be done with the rotor shaft horizontal. The rotor weighed about 5.5 tons, so the truing offered quite a problem. Trucking the armature out to an adjoining city, a distance of twenty miles, was first considered, but the risk of damage was high and a machine job of that size would be rather expensive.

A plan was finally adopted to support the armature in temporary bearings, after some discussion as to what accuracy could be obtained by grinding. It was thought by some that there would be enough movement to cause the commutator to grind out of round.

A crib-like structure was built by laying 12x12-in. timbers on the floor for bearing supports and tying them together with other timbers in such a way that it resembled the base and bearing supports of an ordinary horizontal-shaft motor-generator set. To this structure were fastened two suitable bearings in which to support the armature and allow it to be revolved at the required speed. Fig. 1 shows the assembly with the armature in place. Both armature windings were thoroughly covered with canvas. This was done to prevent copper dust or grit from the grinding stones getting into the windings.

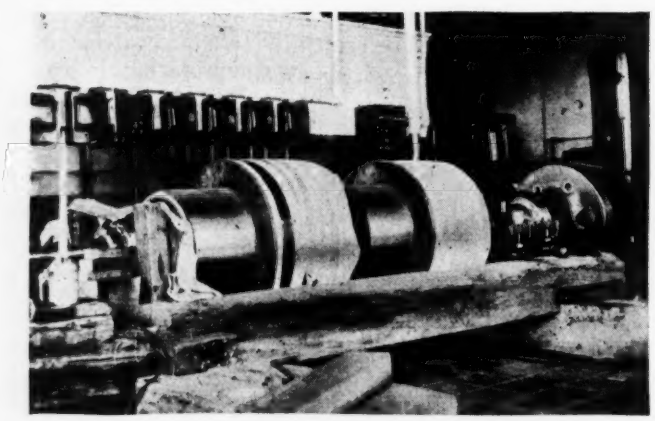

Fig. 1—Armatures mounted in temporary bearings ready for burning the commutators

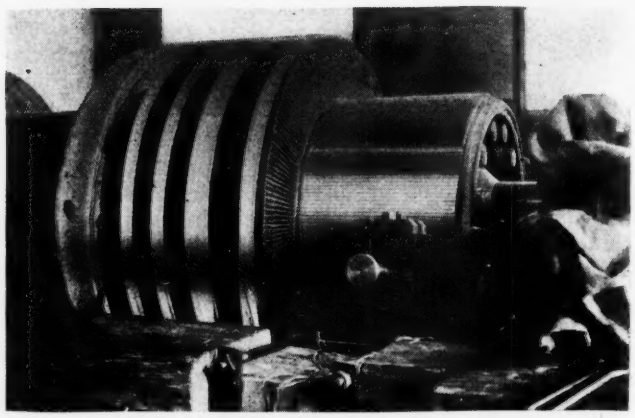

Fig. 2—Grinding stones and steady rest in place for truing one of the commutators

A 30-hp. slip-ring motor was obtained and connected to the armature by a belt. The grinding tool was a combination grinding and turning tool and was mounted on one of the 12x12-in. timbers, as in Fig. 2. This tool operated in the same manner as a lathe tool carriage and was adjustable in or out for amount of cut and moved along horizontally on the face of the commutator while the grinding was in progress.

The job on both the commutators took about two days and required the services of two men. The armature repair man was used to operate the cutting stone and a helper lubricated the bearings. It was found that a four-hour run could be made without any difficulty.

After the rotor was installed in its regular position and bearings, an indicator which read in 0.001 of an inch was held against the commutator and the needle deflection was 0.003 of an inch, whereas when the machine first came from the factory the deflection was 0.015 of an inch. It is doubtful whether a better job could have been done in a lathe with the use of center and steady rests. These measurements do not mean that the commutator itself was out of round, but that the brush surface of the commutator was eccentric to the bearing center. It is believed that a much truer job could have been done if this were desired, but would have required cutting more copper off the commutator.

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THE POPULAR BELIEF regarding the alleged virtues of ozone in recirculated air is debatable and not well founded. Numerous researches have shown that ozone in concentrations permissible in air-conditioning work (0.1 to 0.5 parts per million parts of air) exerts no effect whatever on pathogenic air-borne organisms and it does not destroy odors, but it merely masks them by olfactory compensation. It requires at least 13 parts of ozone per million parts of air to influence bacteria. Since human beings are injuriously affected by ozone in concentrations of one part or more per million parts of air, and since this amount will not destroy odors, nor kill bacteria, nor purify organic matter, the value of ozone in air conditioning is very doubtful.—C. P. Yaglou, *A.S.H.V.E. Journal.*

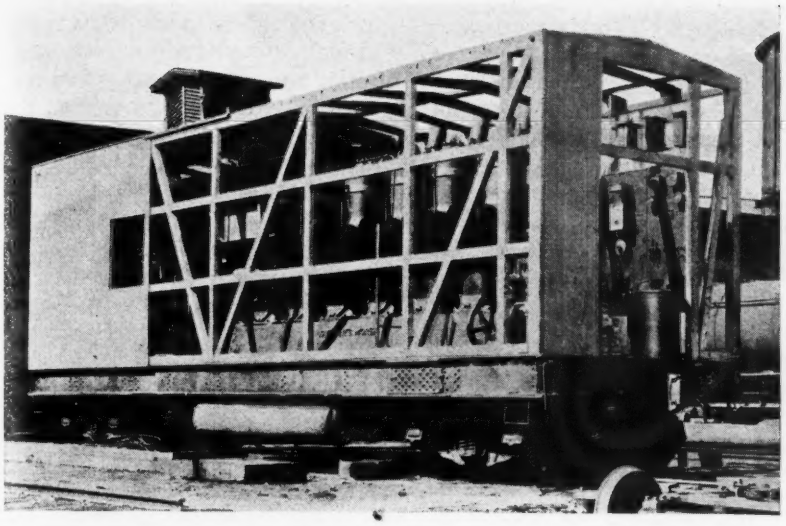


Fig. 1 — Portable railroad plant powered with a diesel

One of the fields for which the diesel engine is particularly suited is the portable power plant. In this application the diesel has a lower fuel cost than a gasoline engine, less labor and objectionable noise than has a steam unit and is more flexible than an electric motor, which is often handicapped by variation in voltage and cycles

Diesel Engines As Portable Power Plants

By OLIVER F. ALLEN

Consulting Engineer
New York City

ANYONE who in passing the excavation for Radio City in New York City has seen the dozens of portable power plants operating there without smoke or other nuisance except noise incidental to such equipment, realizes the progress made during the last few years in contractors' power equipment.

These Radio City units comprise a fleet of shovels driven by large gasoline engines and a larger fleet of direct-connected air compressors driven by smaller engines, plus many miniature pumping units. All of these machines, furnishing the power for three city blocks of rock excavation, could easily be taken away in one evening, after working until quitting time.

Only a few years ago there would have been a large number of steam boilers, much heavier compressor equipment and massive steam shovels belching forth smoke and ashes. Weeks would have been required to install and remove the plant. The work could not have been carried on with anything like the rapidity with which it is being done if only steam equipment had been used. Further reflection brings the realization that diesels for this class of service should offer a substantial reduction in the contractor's daily expenses.

It is interesting to note that the contractors used self-contained prime mover equipment, in the heart of New York City, and not electric motors. Electric motors are very particular about the kind of electricity which is fed to them, and they always have to be hanging onto the end of a power line. The internal-combustion engine uses almost any petroleum fuel. The contractor does not have to worry about volts and cycles when estimating on a new job if his power equipment is gasoline- or oil-engine driven. If his work is in the warmer climates he knows the oil engine's fuel supply is subject to less loss in storage and handling, that it is safer and generally cheaper.

The steam plant was the almost universal portable power unit up to about twenty years ago. During the first ten years of this century the gasoline engine began to be applied where the then-existing regulations did not prohibit its use. Horses, with sweeps, or in tread mills, were still used extensively for small projects, and it is surprising how many hand winches were employed in construction work where gasoline engines are now standard.

Before 1900 tractors, mostly with steam plants, had begun to replace horses in agricultural work where the fields were large enough to permit the use of the cumbersome machines of that day. Up to the beginning of the World War there had been considerable improvement in traction engines, but with the exception of two or three types using kerosene engines, with a modified form of carburetor, those not steam-powered were restricted, in the United States, to gasoline engines. In fact, before the World War the diesel motor for portable and semi-portable applications hardly existed in the United States, although there were a few hot-bulb oil engines used by contractors and farmers. On the other hand, in Europe, and to a lesser degree in England, the oil engine was employed to a considerable extent for

both tractors and portable plants of various capacities.

During the war there was a greater realization than ever before of the practicability of the portable, light-weight internal-combustion engine plant. An idea of the extent to which such units were employed can be had from the fact that the author had at one time under his direct command over 200 such plants ranging in size from little one- or two-horsepower gasoline-engine lighting units for command posts, to substantial oil-engine units for power plants feeding transmission lines and operating large pumping plants. The oil engines available on the French Front were restricted almost entirely to heavy English machines. The American Army had a number of American-built gasoline units, but found the lighter weight, more compact French units generally better suited to these portable applications. Some French manufacturers had been making light-weight, self-contained portable units since 1900.

Since the Armistice there has been considerable development of diesel tractors in England and on the Continent, especially in Germany. The English exports are substantial, and the Germans now have two or three fine designs which, when put upon a mass-production basis, should assure a wide distribution. These are made with wheels and tires of various types to suit the varying needs of highways, fields and other ground on which they may be used. Some are made with wind'ass equipment for rice-field cultivation, and hauling.

Generally speaking, diesels for portable plants for contractors' work, such as driving air compressors, pumps, concrete mixers, rockcrushers and hoists, have been much heavier than the gasoline engine available for the purpose, weighing of the order of 60 to 75 lb. per horsepower. Engines as heavy as this cannot find a large market for portable work any more than they can for automotive services. Furthermore, the heavy engines have operated at relatively low rotative speeds and have been expensive to build and to transport. The low rotative speeds have complicated their application to many services and restricted their ability to withstand the shocks of heavy loads suddenly applied. The great weight required expensive and heavy supporting structure, which again added to the cost of the unit and the difficulty of transporting it.

While engine builders have been satisfied to offer these heavy, slow-speed machines which do meet the needs of some portable applications, electrical manufacturers have carried on intensive and intelligent development of electric motors for these services. The result is that wherever electric power can be made available it is largely to the interest of the farmer and the contractor to use electric motors because they are frequently better suited to the service.

In spite of restrictions imposed by the necessity of cable connections, the electrical people have stolen a march on the diesel manufacturers, both here and abroad. Not only have they developed portable motor units specially adapted to these services, but also portable transformer stations which enable such units to be easily connected temporarily to high-voltage transmission lines. This activity by the utilities and the electrical manufacturers has taught the farmer, the garage owner, the building and road contractors, the country gentleman and the camper the advantages of power and light in isolated and temporary quarters.

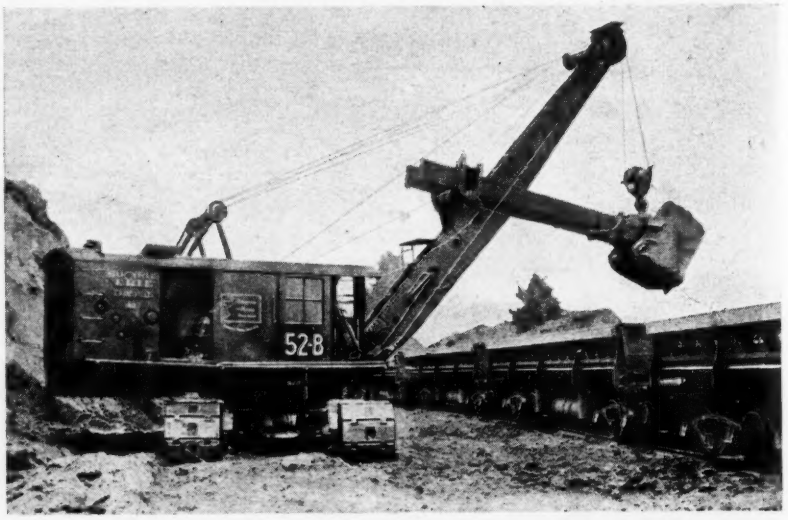


Fig. 2—Shovel operated with diesel power

The gasoline engine partly meets the requirements, but the safe, light-weight, high-speed, compact, oil engine is needed to give service and ease of utilization equal to the electric-transmission system, without its restriction of connecting supply wires.

The farmer and the contractor are by no means the only people who need temporary power plants. Just as the army engineers built substantial plants on railway cars and caterpillar trailers during the war, there is a live demand for portable power plants of that type in peace time.

Some manufacturers, especially in Europe, are giving serious attention to this, but it does not seem to be realized generally how large a volume of business could be developed if a few simple conditions were complied with. For instance, there are a great many small shops and garages that are either located where there are no adequate electric power lines available, or that have occasional need of more power than can be supplied by existing lines or electric motor equipment. The occupant frequently does not own the premises nor has a lease long enough to justify the cost of installation of a normal isolated plant. While one finds that many automobile engines have been pressed into such service, and that there are several makes of both gasoline and oil engines offered for the purpose, there does not seem to exist any standard unit that can be moved about and installed as easily as the electric motor.

With the heavy, normal engine the cost of foundations and connections is so great as practically to prohibit its temporary use. By utilizing available light-weight automotive designs and modifying both design and ratings to suit the changed duty, perhaps also simplifying the cooling by entirely eliminating water jackets, as has been done by Austro-Daimler in a line of small portable diesels

which they are building near Vienna, or making self-contained water-cooled units such as the French Junkers, the weights can be brought down so that the outfit is easily portable, without sacrificing reasonable durability. The unit must be really self-contained, fully inclosed, with no little gadgets stuck around outside, and must be both dust- and rain-proof, with air filters on the intake.

It appears that at the present time diesels running at between 1,200 and 2,400 r.p.m., in sizes from 5 to 75 hp., could be built commercially, weighing not over 20 lb. per horsepower, complete with supporting structure to insure rigidity combined with real portability, and still sufficiently rugged to operate over 4,000 hr. without overhaul. It is not believed that the average portable unit would be called upon to operate more than 1,000 hr. per year. Consequently such a unit would have a life of about four years between overhauls. If put into more severe service, operating 8 hr. per day for 250 days per year, it would still run for two years without general overhaul.

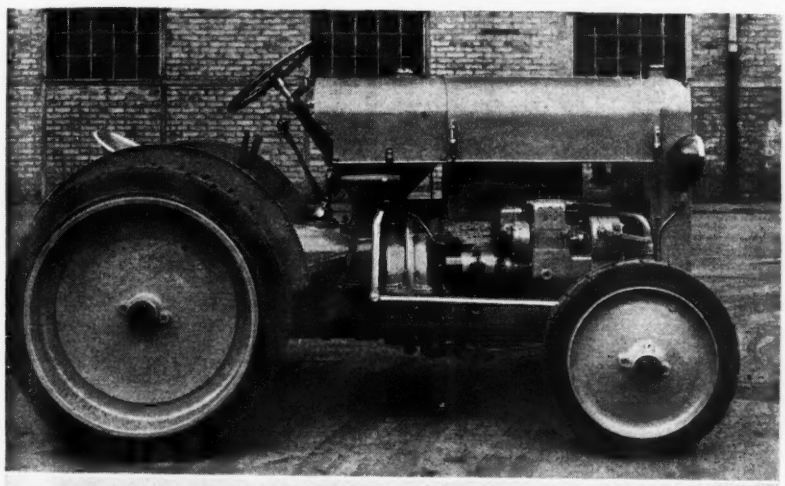
Such units burning the same character of fuel as is now becoming universally available for heating systems would at once have the advantages of lower fuel cost than corresponding gasoline units, combined with much greater safety. From the fire hazard point of view they could be installed anywhere that an electric motor could be used. Operating at high speeds compared with older types, but speeds generally corresponding with those of electric motors of the same powers, they could use the same drive that the electric motors use. It is true that they would require an exhaust pipe, but modern exhaust mufflers do absorb the noise, and the performance of high-speed diesels now on locomotives and in motor buses shows that the exhaust need not be objectionable. In the majority of cases the cost of making exhaust connections would not exceed that of wiring for an electric motor. No special foundation would be required for either. Both could be rolled off a truck, ready for connections.

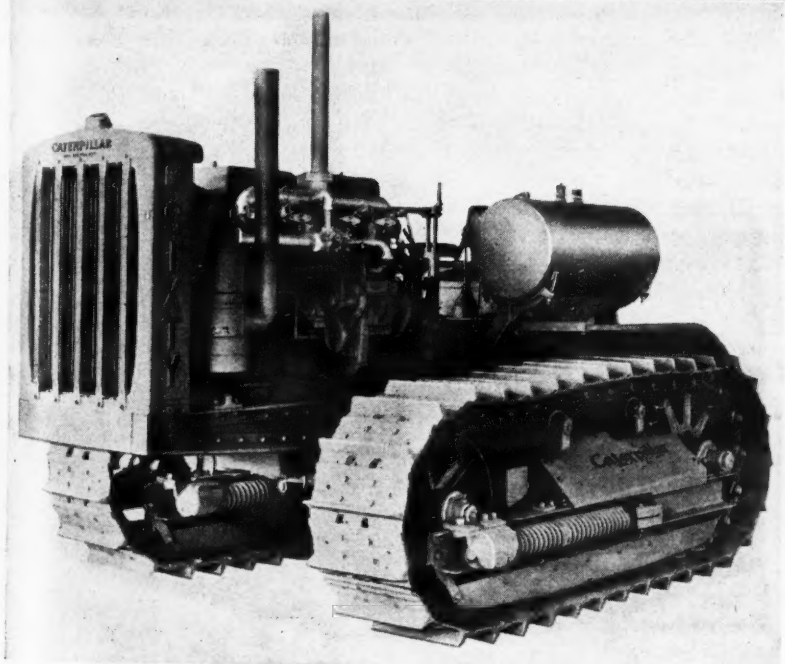
Some of our manufacturers appreciate this trend toward the oil engine and are substituting diesels for gasoline engines on compressor units, power shovels, hoists and rock crushers. But the field is not adequately filled at the present time by any prime mover. There are opportunities to supply power units where no power is now used, as well as to supplement existing types. It is a field which is receiving serious thought abroad, especially in Germany, and considering how much larger our country is, and how much more inclined we are to give our workmen adequate power, no matter what the task, it would seem that there is a more alluring opportunity for the development of such a line of machines in the United States than anywhere else.

Not only is the domestic market a substantial and growing one, but the light weight when, as in the case of the automobile, combined with mass production creates unusual opportunities for export. It is, perhaps, not recognized in this country that some of the European manufacturers are shipping small diesels to South America and other markets by the car load. If the same methods are applied to the development of portable diesel units, there is no reason why we should not have a substantial export business, as well as a large domestic business, as has been the case following the development of the simple, rugged small automobile.

While the large market and most general interest is for the small units, from baby engines of about 1 hp. up to 25 or 30 hp., with a smaller, but still important market for machines up to 100 hp., there is a demand for much larger oil-electric generating units. These range up to, say, 1,000 hp. each, and may be permanently on railway cars or self-contained on skids for easy and quick installation and removal. These are needed for breakdown service as well as for temporary supply during alterations of transmission lines.

Fig. 3 (Above)—Germany builds many diesel tractors, Fig. 4 (Below)—Caterpillar diesel tractor





Making Water Measurements With Current Meters

Current meters are used extensively in Europe for measuring the flow of water to hydro plants. Considerable of this work has been done by S. Bitterli of Rheinfelden, Switzerland, whose son is the author of this article, which presents a résumé of some of the current-meter work that is being done in Europe

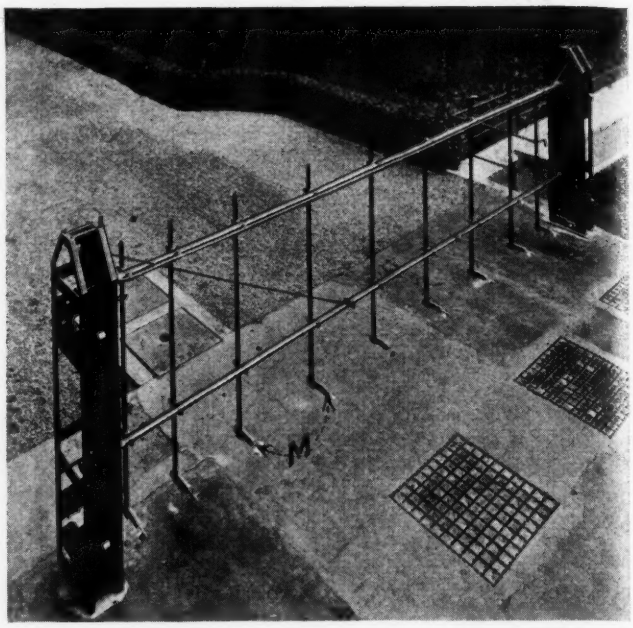


Fig. 1 — Current-meter frame used at Ryburg-Schwoerstadt plant. The current meters are at *M*

By SIGMUND J. BITTERLI
Safe Harbor Water Power Corporation
Baltimore, Md.

THE knowledge of the discharge of a stream, that is, the quantity of water flowing through a given cross-section in a unit of time, is important for all hydraulic tests. No difficulties arise in determining small quantities of water as handled in laboratory tests. Quantities are determined with great accuracy by means of calibrated tanks or by weighing. These methods are not, however, applicable for large discharges. There have been developed several methods, differing considerably in their principle, to measure large quantities. Either they may be determined directly, such as by the Allen, Gibson, salt titration, weir, or other methods, or be obtained indirectly by finding the distribution of velocities with current meters. In Europe current meters are used to determine both small and large quantities of water.

Accurate water measurements are of a great economic importance, especially for Kaplan turbines. It is only by actual tests in the power plant that the most efficient relation between gate opening and blade angle can be determined. The results of such tests enable the power plant operator to utilize the flow with the highest efficiency.

For accurate determination of discharge the velocities perpendicular to a measured cross-section are required. The ideal current meter would be one that registered for all velocities only the component perpendicular to the plane of measurement. Such a meter does not exist, but A. Ott, Kempten, Germany, is constructing current meters, Fig. 2, which for oblique flow up to 15 deg. measure the exact cosine component of the velocity.

Ideal conditions for current-meter use are undisturbed and straight flow of the water parallel to the current meter's axis, that is, perpendicular to the measuring plane. European engineers attempt to approximate as closely as possible these ideal conditions by means of special devices, since in general the intakes of turbines are not favorable to tests. To make them adaptable for current-meter measurement it is often necessary to make temporary installations to obtain such conditions of flow as are needed for the tests.

Such installations are simple wooden structures, which are installed before filling the pond, and are so designed that they can be removed without lowering the head-water level. They cause a small loss of head only. This may be easily determined by measuring, under the same physical conditions and turbine output, the head-water level in front of the rack and in the measuring cross-section and the tailrace-water level with and without the wooden structures installed in the intake.

It requires some experience to determine the number of current-meter measuring points and their distribution in a cross-section. The number of points is computed by the formula given by the Swiss Standards for Water Measurements $n = 4.3$ to $7.65\sqrt{A}$, where A represents the area of the measuring cross-section in square feet. For more unfavorable conditions of flow a greater number of points is required. The spacing of the points should be closer near the walls, the bottom, and the surface, where the greatest variations of velocities are likely to exist.

Formerly, when only small quantities were measured, one current meter was used to register the velocities. To shorten the time required for testing larger discharges and to increase the accuracy of the measurements as many current meters as were necessary to conform to the distribution of the measuring points were arranged on a vertical or horizontal rod. Each current meter had its own observer. This expensive arrangement was

abandoned when Ott built a suitable chronograph, Fig. 3, to record the signals of the current meters and the time on the same chart. Observation of the tape during tests shows if the current meters are operating properly and gives an approximate idea of the velocities.

Fig. 1 shows the frame used for the tests at Ryburg-Schwoerstadt. On a horizontal rod are arranged the ten current meters necessary to determine the values for the horizontal velocity diagrams. The vertical and horizontal rods are streamline-shaped. The end girders are guided in the stoplog slots by rollers on springs and the assembly is moved by hoists. Since vibration would cause the current meters to give readings less than the actual flow, the frame is made so as to prevent this.

Fig. 5 is a portion of a chart from the recorder. These charts are preserved as the official records of the tests. The current meters are supplied with contact wheels giving a long then a short signal for positive velocities and vice versa for reverse flow. When flow conditions are good the duration of observation for one position is 60 sec. For irregular flow the time has to be increased.

Current meters have to be calibrated with the highest degree of accuracy, and have to be handled with extreme care. Calibrations before and after the tests give the necessary information about their condition and accuracy. To insure against errors due to change of shape of the current meters, plaster casts are made by which the slightest deformation that would affect the rating curve may be detected.

The discharge measurement is made graphically by plotting and planimetering the velocity diagrams and the discharge curve. An analytical approximation however, has the advantage that it can be made comparatively quickly and allows seeing whether the results are reasonable or not before leaving the field. The analytical determination always gives a result higher by about 1 per cent.

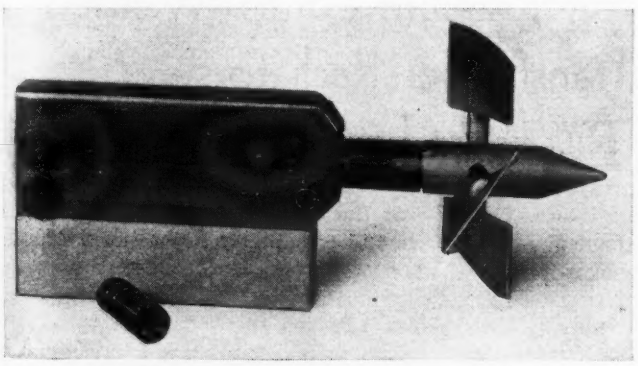


Fig. 2—A type of current meter used in hydro-plant tests

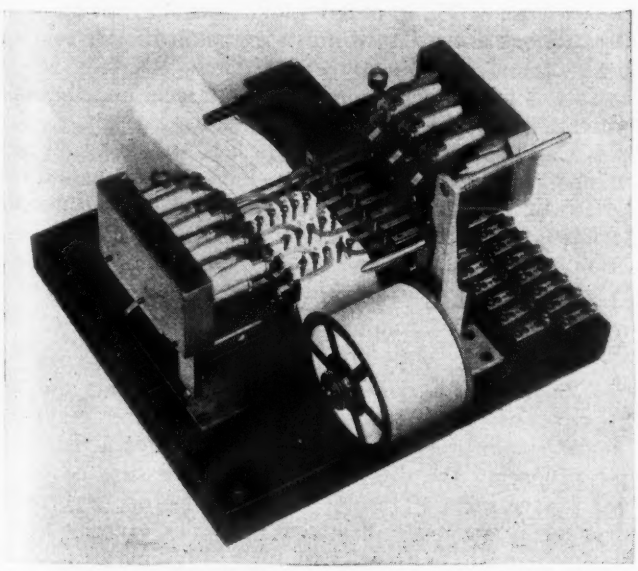


Fig. 3—Graphic-type chronograph for recording current-meter signals

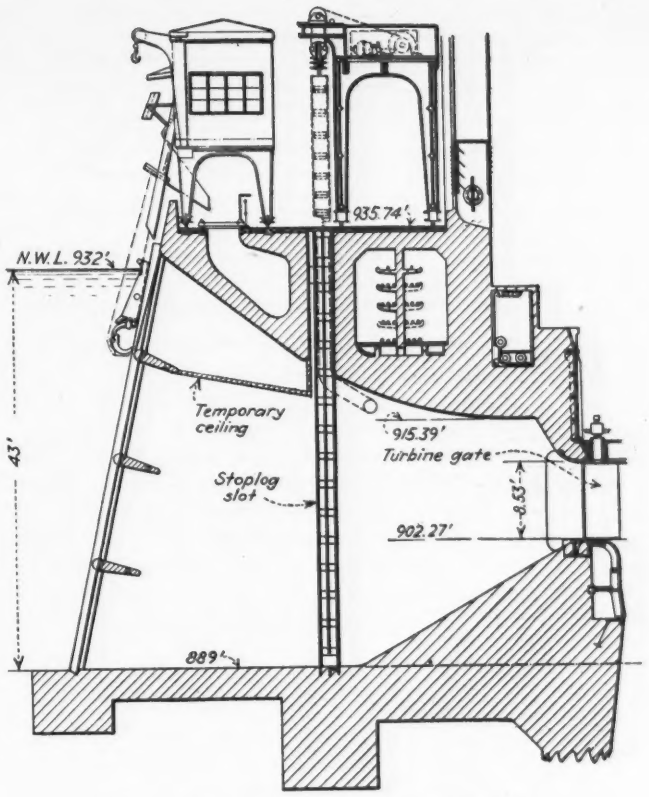


Fig. 4—Cross-section of intake to one of the Ryburg-Schwoerstadt turbines

The temporary ceiling used when making the tests is shown. The current-meter frame was lowered into the stop-log slots.

In the new hydro-electric plant at Ryburg-Schwoerstadt, on the Rhine, there are installed four Kaplan turbines of unusual size. (See *V.D.I. Zeitschrift,* Vol. 75, Nos. 13 and 15, and *Power,* April 1, 1930, page 515.) In respect to discharge capacity they are the largest Kaplan turbines so far in operation. They were built by Ateliers des Charmilles, Geneva; Escher Wyss & Cie, Zurich; and T. M. Voith, Heidenheim. Their maximum output is 38,200 hp. at 75 r.p.m. with a discharge of 10,400 sec.-ft. under a 37.75-ft. head. Fig. 4 shows a cross-section with the temporary ceiling constructed for the purpose of making the flow conditions suitable for current meters.

Measurements of discharge were made in the turbine's intake. Each intake is divided vertically into three sections, the measuring cross-section of each being 23.25 ft. wide and 28.83 ft. high. Ten current meters were used on each of the three frames and were moved in the stoplog slots, Fig. 1. The signals of the current meters were automatically registered by ribbon chronographs, one for each section of the intake. The smallest quantity of water measured was 2,010 sec.-ft. and the largest 11,300 sec.-ft. The Kaplan turbine was tested for six blade angles and each was held constant for four different gate openings. This gave a total of 24 complete measurements, each with 360 measuring points. The average duration of one complete discharge determination was 22 minutes.

Fig. 6 shows the measured and guaranteed efficiency

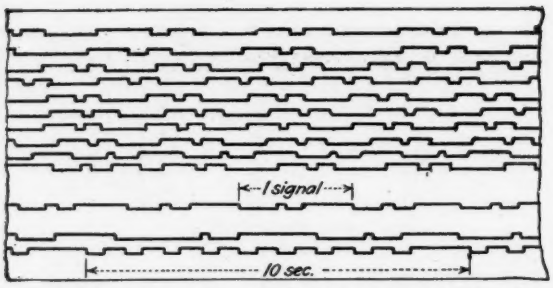


Fig. 5—Portion of a chart obtained of current-meter signals

of the turbine as a function of its output at a head of 35 ft. From 12,000 to 34,500 hp. the efficiency is above 90 per cent; the maximum is 92.7 per cent at 23,750 horsepower.

The four three-phase generators were designed and constructed by Brown Boveri, Baden and Mannheim, and are rated at 35,000 kva., 10,500 volts, 0.7 power factor, 50 cycles. The over-all efficiency based on generator output, is shown in Fig. 7, and is above 85 per

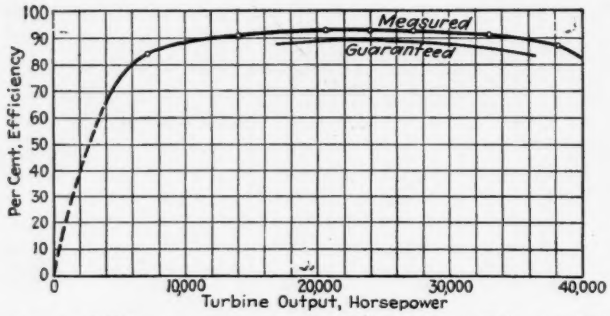


Fig. 6—Efficiency curves of one of the Ryburg-Schwoerstadt Turbines

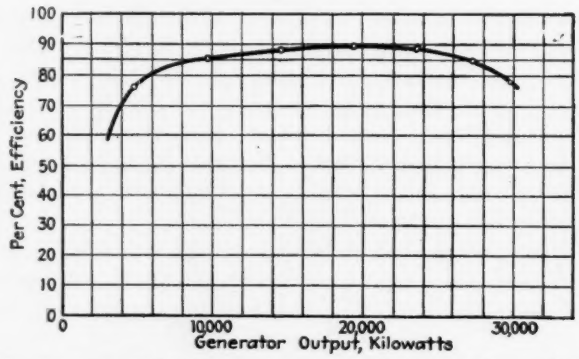


Fig. 7—Over-all efficiency of one of the Ryburg-Schwoerstadt units

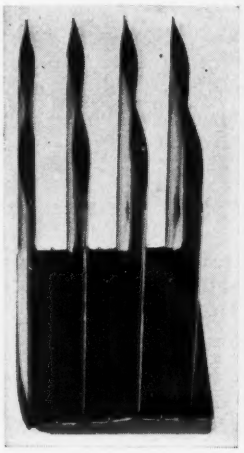
cent between 9,000 and 27,000 kw. The maximum efficiency is nearly 90 per cent.

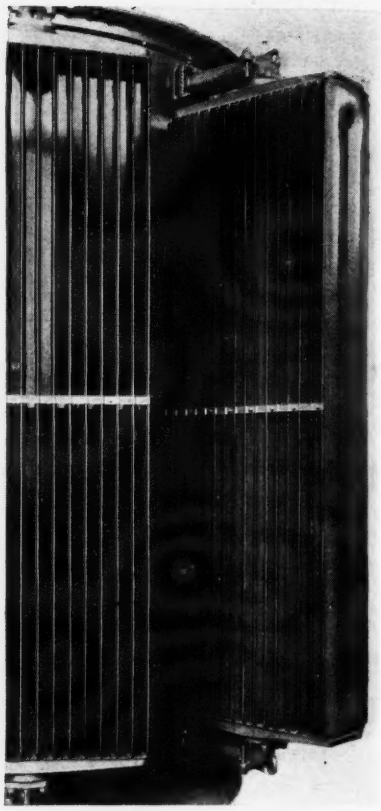
Methods of making acceptance tests in Europe differ distinctly from those used in America. Each method possesses its particular advantages, but has peculiarities that must be mastered before satifactory results may be obtained. Unfortunately there exists considerable prejudice on the two continents against the use of testing methods that have apparently given satisfaction in the other. It is desirable therefore that truly comparative tests could be made.

Various attempts to secure comparative results have been made. As each method requires the technique of those who are familiar with their own methods, such comparisons cannot be successfully made unless the respective experts can be present in the field. It is hoped, therefore, that such tests can be made either in America or Europe with the advocates of the various methods actually present.

Fig. 1 (Below) — Looking down on a group of assembled cooling sections

Fig. 2 (Right) — Finished radiator attached to a transformer tank





Air Pressure Forms Welded Transformer Radiators

TWO LONG strips of 0.05-in.-thick steel, welded together around the edges and then blown up by air pressure, is the way Westinghouse makes transformer radiators. A pair of flat steel sheets cut to the right shape are placed back to back and welded airtight around the rim and then spot-welded down the center for strength before being deformed. This flat airtight assembly is then placed between the retaining walls of a jig, and 90 lb. per square inch air pressure, corresponding to 500 per cent normal working pressure, inflates the steel shell to produce a light and substantial cooling section. After welding, inflating and forming, several cooling sections are grouped into a common header to form the radiator.

Care is taken that the welds do not leak, and the complete assembly of the radiator is stood upright and 80 deg. C. oil at 15 lb. per square inch is circulated through it for two hours. All welded surfaces are on the outside, where they can be easily inspected and quickly cleaned and painted.

▼

FOREVER bound up with the memory of James Watt is his controversy with Richard Trevithick, inventor of the steam locomotive. Pioneer himself, Watt did not approve of Trevithick's advances into the realm of "high" steam pressure. He called the latter a murderer for proposing the use of steam at a pressure of 40 lb. per square inch. This bit of power history is brought to mind by the recent death of Frederick Harvey Trevithick, grandson of the inventor, and himself a noted railway engineer.

Low-Temperature Carbonization For Brazilian Coal

BRAZIL, although covering an area much greater than the United States, is not rich in extent and quality of coal deposits. Some small mining operations have been carried on in the State of Santa Catherina, but the seam is thin and the coal low in calorific value. The principal mining activities are at present confined to the County of Sao Jeronymo, in the southern State of Rio Grande do Sul. This coal is not very high in quality, being a sub-bituminous with a large percentage of extraneous ash and ordinarily considered non-coking in character.

As shipped from the mines the coal runs about as follows:

	Per Cent
Moisture	10.80
Volatile matter	27.70
Fixed carbon	32.50
Ash	29.00
Total	100.00

Sulphur, 2.53
B.t.u. per lb., 8,400.

Mining methods are not the most modern, nor is preparation at the tipple, and part of the high ash content is due to lack of proper mining and cleaning.

This coal is at present used as fuel in the steam-electric station of the Companhia Engergia Electrica Rio Grandense, a subsidiary of the American & Foreign Power Company, which supplies light and power to the city of Porto Alegre, capital of the State of Rio Grande do Sul. The coal is fired under the boilers in pulverized form. This company also operates the gas works which supply coal gas to the same city, the present fuel being imported gas coal.

Tests Made in United States

Believing the local coal to have possibilities as a source of coal gas as well as of the valuable tar and other by-products, the C.E.E.R.G. has had a number of laboratory experiments made in the United States on this coal, some of them being of semi-commercial proportions. As a result of these tests the company is now installing a complete plant unit, capable of expansion by the addition of further and similar units, for gas production using the local coal as raw material.

This new installation will be located adjacent to the company's steam-electric plant at Porto Alegre. Coal entering the gas plant will be washed to about 75 per cent recovery in twin hydrators to reduce the sulphur and ash content and, after being dried by preheating, will be carbonized in a revolving retort at low temperature.

The semi-coke residue from this gas plant, at least during the early years of development, will be used under the boilers of the adjacent steam-electric station, where it has numerous advantages, as a pulverized fuel, over the raw local coal now used.

The gas produced, after being scrubbed for the removal of the tar, light oils for motor fuel, and purified, will go to the gas distribution mains of the city. The primary tar produced will be treated for the recovery of motor fuel, light oils and cresols, the residues being made up into road-building materials.

Low-temperature carbonization was chosen for this plant because of the greater yield of liquid byproducts. Brazil has no commercial production of petroleum nor yet any known reserves. Thus all motor fuel as well as all lubricating and other mineral oils are imported. The resulting high prices have been a definite factor in restricting the use of motor cars in the country.

The market situation in Brazil as regards other products recoverable from primary tar—disinfectants, creosotes, sheep and cattle dips, road building tars, particularly—is much more favorable to profitable operation of low-temperature carbonization than the North American market for similar products. The development, within the country, of a supply source which can furnish these materials at a reasonable price is highly important to the industrial and agricultural development of Brazil.

Potential Market in Highways

Perhaps no other single factor has exerted a greater influence on the cultural and economic development of Brazil than the lack of adequate transportation facilities, principally roads. Beyond the mileage of railroads, mostly meter gage, and on which tariffs are comparatively high, land transportation such as is found in Europe and North America has not yet been developed. Good roads exist in and around the large cities, but the vast country lying back of the narrow fringe along the Atlantic seacoast relies in general on less modern methods of travel and transport. As a result there are many scattered and isolated towns and communities between which the free and economical interchange of manufactured or agricultural products is difficult except in certain limited areas. The development of an economical source, within the country, of the pitch binders and road oils necessary for road construction offers an opportunity for the commercial development of low-temperature carbonization that is lacking in countries where other and cheaper sources of these materials have existed.

Porto Alegre is situated in a climate almost semi-tropical, corresponding about to that of South Georgia in the United States. Practically no attempt is made at domestic heating, and consequently there is only a small demand for the solid, smokeless fuel, lump coke, which has been the bugbear of so many low-temperature carbonization installations. Coke for metallurgical purposes, although selling at a good price, has such a restricted market as to eliminate it from consideration in the economics of a gas and byproducts plant at this time.

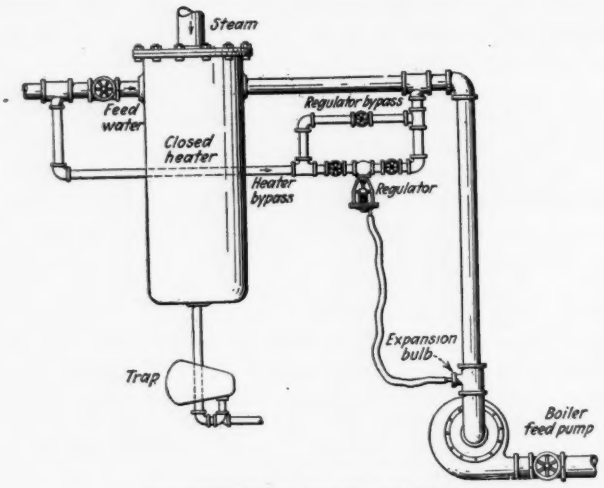
Practically all factors governing the economic set-up of this gas plant, therefore, have indicated advantages in favor of low-temperature carbonization—a continuous market for the semi-coke in the steam-electric plant, a growing local gas demand for cooking, water heating and industrial purposes, and an expanding national market for the liquid byproducts and their derivatives at prices sufficient to justify the processing of the primary tar. That this plant will be the first domestic source of these products in Brazil is a further factor in favor of its economic success.

Probably no installation of the low-temperature carbonization process made in the Western Hemisphere has had a more completely favorable economic situation than appears to govern the new Porto Alegre gas plant. The results obtained will be watched with keen interest by the many engineers and executives in the United States interested in the technology and economics of this process. These results will also be vitally interesting to Brazil, since the process appears to offer the best practical means of offsetting the lack of petroleum reserves and of developing a domestic source of those tar byproducts so necessary to her industrial expansion.

PRACTICAL AIDS TO OPERATION

Control for Feed-Water Temperature

A CLOSED feed-water heater was installed at a plant and piped to the boiler feed pump as shown in the illustration. It was found after installation that on peak loads a higher temperature rise through the heater was obtained than expected. At times the temperature of the feed water at the suction of the feed pump was so high for the available suction head as to cause partial steam-binding of the pump. The location of the heater and the pump could not be changed to give a greater suction head without considerable expense, and as this trouble did not occur frequently some other arrangement for its prevention was desired. A control which automatically bypassed the heater enough to hold the suction temperature at its maximum possible operating temperature at such times was installed as shown.



Arrangement of heater and bypass

Milford, N. J. H. M. SPRING.

Shunt Load Balances Battery Discharge

A STORAGE BATTERY for stand-by purposes is normal equipment for practically all power houses. One hydro-electric plant was recently confronted with the necessity of providing two control voltages, from one battery and at the same time to obtain a balanced discharge throughout the cells. The auxiliary rotating equipment is designed for 250-volt direct-current operation, whereas the generator oil switches and the emergency lights are on 125 volts. The plant is provided with a 120-cell, 400-ampere-hour battery.

A simple method was employed to obtain a balanced discharge of the cells. The variable load consisting of the 250-volt rotating equipment was connected directly across the battery, and the variable-load consisting of the 125-volt control and the emergency lights was connected permanently across one side and the mid-point, as in the diagram. Across the other side and the midpoint was connected a hand-operated rheostat of proper rating together with a lamp to act as a shunt load. The variable 125-volt load was predetermined as accurately as possible and the rheostat was adjusted to balance this load. The lamp was provided to furnish a visible proof that the circuit was complete, otherwise an open circuit might not be immediately detected. A monthly check is made on each cell for gravity and voltage.

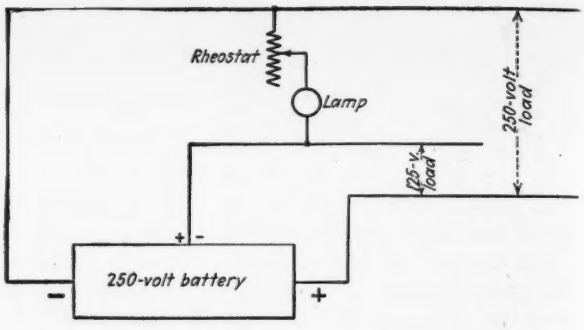


Diagram of battery and load connections

While the control load is variable and the shunt load may not be set to a permanent value, the monthly checks indicate that there is a fairly balanced discharge between the two halves of the battery. Normally only a slight adjustment of the rheostat is necessary.

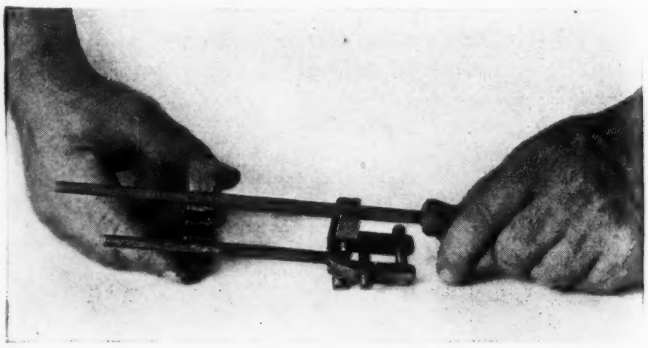
Tapoco, N. C. S. B. STOUGHTON.

Relocating Welded Gear Teeth

ON SEVERAL OCCASIONS I have had the job of filing out new teeth on a stripped part of a gear that has been welded, and it occurred to me that the method I use to locate the new teeth might be of interest to other readers. I eliminate all laying off and use a direct method, as shown in the illustration. I select a round file and a short length of rod that will lie nicely in the teeth. Then I use two clamps, one I tighten on the file and the other I use to tighten the rod on the first clamp at a distance that enables both file and rod to lie in the teeth—three or four teeth apart. I can then locate the first tooth in the correct position by keeping the rod between the teeth as I file.

By moving the rod one tooth at a time all the rest of the new teeth can be located with the file. Once this location is filed deep enough to act as a guide I use the file with the rod out of the teeth. W. H. MOORE.

Hamilton, Ont.



Guide attached to file locating gear teeth

CURRENT COMMENT

Open-Delta and Closed-Delta Banks of Transformers in Parallel

I HAVE READ with interest the answers to the question on connecting a closed-delta bank of transformers in parallel with an open-delta bank, in the Dec. 15 number of *Power*. I am surprised to note that no one has suggested the logical solution of connecting an impedance in series with the single transformer and thus increasing the capacity of the banks from 80 per cent to 95 per cent. This impedance would have to increase the percentage impedance of the single transformer by approximately 40 per cent in order to be able to load the banks to 95 per cent of their full rating.

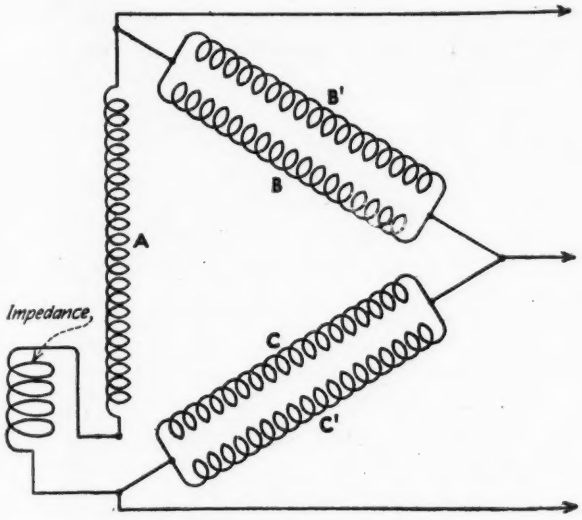


Diagram of a closed delta and an open-delta bank of transformers in parallel, with an impedance in series with transformer *A* of the closed-delta bank

Lynchburg, Va. H. D. FORSYTH.

Conservation of the Heat in Blowdown

IN THE Dec. 15, 1931, number of *Power* there was a question and answer dealing with the amount of heat that can be recovered from blowdown, and the size of the flash tank. In the question the blowdown entered at 460 deg. F. and the feed water was to be raised from 75 deg. F. and the blowndown exit temperature was to be 115 deg. F.

Why does the questioner only reduce the blowdown temperature from 460 deg. to 115 deg. when he has ample make-up water with an initial temperature of 75 deg.? It would seem that it would be profitable to increase the size of the heat exchanger and reduce the temperature of the blowdown from 460 deg. to, say, 85 deg. The heat exchanger unit would be relatively small and the increase in exchange surface necessary would represent a very small expenditure, which would soon be recompensed by the saving in heat units.

The flashing of blowdown water into the entrance of heat exchangers is a problem worthy of considerable attention. Heat exchangers of the coil type seem to be particularly susceptible to erosion because the flashing of blowdown water at the entrance of the heat exchanger causes an immediate impingement against the relatively soft copper coil.

In the case in point a reduction in pressure from 450 lb. gage to 400 lb. will cause 1.34 per cent of the blowdown water to flash. At the boiler there will be a total of 71,884 cu.in. of water flowing per hour, but at the entrance of the heat exchanger 70,921 in, of water and 63,664 cu.in. of steam, making a total of 134,585 cu.in. of combined steam and water. The velocity of the mixture, therefore, will be almost twice as great at the entrance to the heat exchanger as it is leaving the boiler. A certain reduction in temperature will, of course, take place between the boiler and the heat exchanger due to radiation loss. For practical purposes it is well to ignore this radiation loss, as it is usually very small, and moreover should be kept so by insulating the pipe.

Proper proportioning of the blowdown piping, proper design of the heat exchanger and coordination of the system are important items.

Much expense and trouble has been experienced by users of continuous blowdown systems with heat exchangers, because these important details were not taken into consideration, and as a result flashing with a subsequent erosion and destruction of the heat exchanger unit was experienced.

Regarding the dimensions of flash tanks, it has been my experience that a flash tank properly designed and having about 7 sq.ft. of water surface per 1,000 lb. of flash per hour will give excellent results. The 42-in. x 8-ft. tank recommended in the answer should be adequate for the quantity given in the problem.

Elgin, Ill. E. F. ECKEL,
Elgin Softener Corporation.

Boiler Operation at High Rating With Minimum Refractory Repair

MANY ENGINEERS are so obsessed with the idea that the refractories should be made to stand up as long as possible that they operate boilers at or near rating regardless of the fact that ultimate economy might be better served by operation at high rating even though it were necessary to make more frequent refractory repairs.

Pulverized fuel, with its quick response to load changes and its ability to utilize full furnace volume and so burn a maximum amount of fuel per unit of time, makes it easier and more worth while to develop high evaporation rates when conditions demand. Yet engineers operating the smaller units are failing to take advantage of this important feature. Another fact frequently overlooked is that the air-cooled wall, where the air is drawn into the pulverizer to be used first for drying the coal and later as preheated secondary air, not only improves over-all economy, but extends appreciably the maximum rate of evaporation without endangering the furnace

walls. A specific instance covering an operating period of more than three years may serve to emphasize the importance of employing first-class furnace construction and using the air-cooled wall to make it practical and economical to operate at high rating.

As pointed out in *Power*, Oct. 7, 1930, the George Ziegler Company, of Milwaukee, was operating two Parker boilers, each with 1,960 sq.ft. of surface, at a pressure of 150 lb. These boilers were installed in 1907, but were equipped with pulverizers which went into service on July 9, 1928. The boilers are set in a battery, the intervening wall being only 18 in. thick owing to interference of a steel supporting column. The furnace floor of each boiler is $7\frac{1}{2}$ ft. from the lower row of tubes. The walls are spaced $6\frac{3}{4}$ ft. at the center of the furnace, with a taper of 4 in. to the top. The length is 19 ft., giving a total combustion volume of 982 cu.ft. The over-all width of the outside walls is 21 in. These walls are air-cooled, the air being drawn off at the boiler front through a duct to the pulverizer, and then directed to the furnace, with the fuel. Although the boilers were originally installed in 1907, it was found after installing the air-cooled monolithic setting and using pulverized fuel that it became possible to operate each boiler at 250 to 300 per cent rating for hours at a time. So high a rating for this specific installation was not developed at the start, but gradually as the shutdown periods for inspection and cleaning demonstrated that the refractory showed no signs of spawling or cracks. Since July 9, 1928, it has been the practice to operate one unit continuously for six weeks, closing down and then operating the other unit for an equal period. Experience with a furnace lining under severe operating conditions, therefore, dates back for better than three years. During this time only three repairs have been made to the two furnaces, as follows:

Date	Nature of Repairs	Costs
Sept., 1929,	Repairing rear wall, unit No. 1	$122.98
Sept., 1930,	Repairing rear wall, unit No. 2	142.36
March, 1931,	Patching walls, unit No. 1	125.14
Total		$390.48

From the time the boilers were started up until the end of October, 1931, approximately 7,470 tons of coal being burned, giving a furnace repair cost of 2.61c. per furnace per ton and a cost of $130.16 per year for the two furnaces, or less than $65 per furnace per year.

Had these furnaces been operated at low rating, the fixed charges alone on the additional furnace that would have been required would have equaled the repair cost of the two furnaces without including the fixed charges on a unit pulverizer, the additional boiler and the cost of operating the pulverizer. At relatively low repair cost the installation of a third boiler was obviated and the operating cost of the existing installation reduced.

While credit for some of this low furnace upkeep expense, and the possibility of operating at high rating, rests with the use of a one-piece furnace lining and a flexible anchorage that enables it to move freely under the influence of expansion and contraction, the air cooling of the furnace walls was an important factor. Air flow and air temperature through the walls can be regulated to maintain a safe refractory temperature. A balanced draft condition may be maintained in the furnace with safety, since the heat seeping into the refractory is carried off by the air to be used for drying the coal and then again as secondary combustion air, so that thermal efficiency is improved and at the same time the refractories are protected. H. S. PRICE.

Milwaukee, Wis.

Preheating Air With Steam

MY ATTENTION has been called to a question and answer in the Oct. 27, 1931, number dealing with the preheating of air with steam.

The analysis of the problem does not reflect the modern concept in regard to heat transmission, and results in a final preheated air temperature considerably different from that possible. Objection is taken to the factor of 2 for the coefficient of heat transfer from condensing steam to air, although it is realized that engineers in the past have used a figure of this order for such problems.

The following analysis is based on the most recent reliable information:

Heat transfer in this type of problem is governed by the series resistance to heat flow through the condensing steam film, the condenser tube wall and the air film. However, the resistance of the steam film and tube wall is small compared to the resistance of the air film, which is the governing factor in this problem, so that only the heat transfer coefficient of the air film need be considered.

The heat transfer coefficient of the air film is determined from the following equation:

$$h_g = \frac{0.22\, C_p T_f^{\frac{2}{3}} v^{0.8}}{D^{0.2}}$$

where

h_g = B.t.u. per hour per sq.ft. per degree temperature difference.
C_p = Specific heat at constant pressure.
T_f = Mean temperature of gas film in deg. F. abs.
v = Pounds of gas per second per square foot of free area.
D = Equivalent diameter of the gas passage in inches.

The numerical values for evaluating the air film coefficient are as follows:

$C_p = 0.24$

$(T_f)^{\frac{2}{3}} = (460 + 200)^{\frac{2}{3}} = 75.7$, where the air film temperature is taken as 200 deg. F.,

$(D)^{0.2} = (0.75)^{0.2} = 0.94$, and

$$(v)^{0.8} = \left(\frac{(268)(144)}{60(0.37)^2(3.1416)(600)}\right)^{0.8} = 2.081.$$

By substituting these values in the original equation:

$$h_g = \frac{0.22 \times 0.24 \times 75.7 \times 2.081}{0.94} = 8.85.$$

By making a heat balance and utilizing the logarithmic mean temperature difference in preference to the arithmetic mean as used in the original solution, and setting X as the air exit temperature, we have

$$16{,}084 \times 0.24(X - 60) = \frac{[(220 - 60) - (220 - X)]}{2.3 \log\left(\frac{160}{220 - X}\right)} \times 707 \times 8.85$$

and $X = 188$ deg. F. as the final air temperature from heater.

It will be observed that this method of solution differs from the method appearing in *Power* in two respects, namely, the determination of the correct heat transfer coefficient for this particular problem and the use of the logarithmic temperature difference.

East Rochester, N. Y. R. E. FULREADER.

READERS' PROBLEMS

CAPACITY OF AN AMMONIA COMPRESSOR—*What is the general formula for finding the capacity of a double-acting ammonia compressor in terms of tons of refrigeration?* J. R. D.

The formula for the *theoretical capacity*, in tons of refrigeration per 24 hours, of a double-acting compressor, taking into consideration the specified pressures in the condenser and the refrigerator, is:

$$T = \frac{d^2 \times 0.7854 \times L \times 2 \times N \times h}{1728 \times 200}$$

T = Tons refrigeration in 24 hours.
d = Diameter of compressor in inches.
L = Stroke in inches.
N = Number of revolutions per minute.
h = Refrigerating effect of one cubic foot of ammonia vapor at refrigerator pressure, completely evaporated from liquid at condenser pressure.

$$= \frac{H_1 - h_2}{c}$$

H_1 = Total heat at the suction pressure and temperature. This may be found in a table of the properties of ammonia.
h_2 = Heat of the liquid at the condenser pressure, also found in the tables.
200 = B.t.u. per minute, equivalent to a duty of one ton of refrigeration.
c = Number cubic feet of vapor in one pound of ammonia at the suction pressure.

For a single-acting single-cylinder machine divide by 2.

AVOIDING CLINKERING BY USING STEAM JETS—*We are troubled with hard clinkers adhering to the side wall of the furnace. Other than installing air-cooled blocks, what can be done to eliminate this trouble? Hand firing is practiced.* S. C.

In some plants the engineers have found that steam jets placed under the grates eliminate this difficulty. The jets do not need to be in action save when the grates are being shaken.

MEANING OF MASS AND WEIGHT—*Will you explain the difference between mass and weight?* C. R. D.

A basic principle of physics is that a body will continue to move at its present velocity unless acted upon by an external agency. This agency is called "force." If the velocity of an object is changed, the change per second is $\frac{V_1 - V_2}{t}$ and is called acceleration a. The force causing this change is F and it is obvious that the acceleration a is proportional to the force F exerted. We can then set up an expression $F = Ma$ when M is the ratio between F and a. This ratio M is called the mass of an object.

If an object be dropped it is possible to measure the acceleration exerted by the attraction of the earth. This acceleration has been found experimentally to be approximately 32 ft. per second and is termed "gravity" and is distinguished by the letter g in place of a. If we place an object upon a spring scale, the scale registers the pull of the earth upon the object, or the force exerted. This force we term weight or W. Since it has been shown that $F = Ma$, it follows that $F = W = Mg$.

CORROSION OF IRON PIPE—*The wrought-iron hot-water piping on the top floors of our building is being eaten out by the action of oxygen from closed heaters. Would it be advisable to replace this section with brass or copper pipe or would galvanic action still cause trouble? It is not possible to change to deaërating heaters at present.* J. A. MCI.

Replacing the iron pipe with brass pipe should materially lessen the corrosion, but it should be understood that under certain conditions oxygen and other gases in the water will attack the zinc in the brass. Copper pipe, so far as is known, is free from this form of corrosion. Galvanic action might occur, but its effect should be negligible and would occur at any event only at the junction of the copper and iron pipe. Before making the alteration it would be well to compare the relative costs of a deaërating heater and the new pipe.

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Good Operating Practice Requires Load Tests on Motors

THE QUESTION

WE HAVE HAD considerable discussion on the necessity of checking up on motor loads, without having established a general practice in our plant for doing this work. I should like to hear from some of POWER's *readers as to what their practice is in making load tests on motors. How frequently should this be done? What use is made of the meter reading? What kind of meters are used for these tests and what benefits have been obtained from them? We have a connected motor load of about 2,700 hp., the individual motors ranging in size from 2 to 250 horsepower.* C. O. H.

THE SITUATION at our plant is quite similar to the one in the question. We have 677 motors, ranging from fractional to 125-hp. capacity, the connected load being 3,600 hp. We do not test motors for load on a definite schedule because there are so many machines whose operating characteristics remain the same from day to day there is really no need for it. Every new installation should be tested as soon as it is put into operation to find out if the motor is suitable for the job. However, our meters are in use practically all the time, the voltmeter and ammeter on trouble-shooting and the graphic meter on drives where a change has been made or where an analysis of conditions is wanted prior to proposed changes.

Our power service is 2,400, 220 and 110 volts, 60 cycles, 3 phases and single phase. For test purposes we use an alternating-current voltmeter, range 0 to 150 and 0 to 300; an alternating-current ammeter, range 0 to 5; a kilowatt meter, range 0 to 1.5, maximum volts 150 and 300, maximum amperes 7.5; a current transformer, capacity 5 volt-amperes, frequency 25 to 133, line volts 2,500; a graphic wattmeter, 3 phases, 5 amp, 100 to 200 volts, scale range 0 to 200, chart speed 3, 6 and 12 in. per hour; and a megohm insulation meter, range 0 to 100 megohms.

During each test the voltage, amperes and kilowatts are taken on each phase and the speed and temperature of the motor are noted. These readings are recorded for analysis and should be taken at intervals if the voltage or load fluctuates. The recording wattmeter is left connected to the motor for a day or longer in order to get an average picture of the variations of the load.

The voltmeter will show if the voltage is correct and a comparison of the voltmeter and ammeter readings of each phase will show whether the load is divided equally on all phases. A comparison of the voltmeter and ammeter readings with the kilowatt-meter reading will give the power factor of the motor. The kilowatt meter will indicate the actual load on the motor and the graphic meter will show the load range of the motor. The megohm meter will indicate the condition of the insulation on the motor and power lines.

With this data a study can be made of almost any condition and steps taken to improve operation. Motors can be chosen to operate at the best load conditions, thereby increasing the efficiency and power factor of the system. A high-torque motor may be chosen to avoid

overmotoring where heavy loads are started. The advantage of having the necessary instruments are too numerous to mention, and it would be costly to try to operate a fair-sized plant without them. ELMER N. ANDERSON.

Austin, Minn.

—

CHECKING OF MOTORS in our plants started primarily as a means of eliminating poor power factor equipment. From this beginning this service has developed into the most important means of obtaining correct motor applications for various equipment. Approximately 10,000 motors, varying in size from ¼ to 200 hp., are installed in these plants.

No definite schedule for checking motors is outlined, but a continuous watch is made by the oilers for motors operating at temperatures either above or below normal. When one is noticed it is reported and a check made. If found to be of incorrect size for the actual load, or having a mechanical defect, it is replaced as soon as possible.

Motors on all new equipment are checked to see that they are properly sized for the job to be done. Also, whenever any motor trouble develops on machinery the motor is checked.

After the actual load check, a follow-up is made to see that the recommendations of the engineer are carried out and that his conclusions were correct. The records of these load checks and recommendations are kept on file for reference when information on similar equipment is desired.

For tests of short duration a portable indicating wattmeter, voltmeter and ammeter are used. These are connected in at the disconnect switch installed on each motor. On larger motors it is necessary to use current transformers and on the higher voltages, potential transformers. When motor checks over a longer period are considered necessary a graphic wattmeter is installed for the period desired.

This means of obtaining load checks on the motors provides low-cost data which have paid big dividends both in power factor improvement and reduced motor maintenance costs.

ROBERT W. WORLEY.

Anderson, Ind.

—

A MORE specific answer could be given to C.O.H.'s question if the type of plant were known. However, the following will perhaps help, inasmuch as it is a system applied successfully to a manufacturing plant which has a total connected load of 1,127 hp., consisting of 117 motors ranging in size from fractional to 100 horsepower.

In this plant a practical electrician is in charge of all routine maintenance and testing in all departments. Having only one man for this work is considered better than using several and dividing the responsibility. At the start of this service the chief difficulty was in conveying to the electrician the exact duties expected of him. It has been found best to provide from the start complete written instructions. In so doing there cannot be the excuse that it was not clearly known what was expected. It is next to impossible to put a new man on the job and expect him consistently to do everything he is told. The items included in the instructions will vary with the individual plant.

As regards periodic load testing, the instructions in effect in the plant in question were to learn which of the motors were likely to be subject to overload, because of variation in load, voltage, phase balance, or abnormal condition in the driven machine. This group of motors was placed on a schedule chart and arranged as to location, department, room, etc. The motors were inspected each 30 days and the data recorded together with remarks that might be of value to the superintendent in determining necessary repairs and alterations.

To make the monthly load tests properly the electrician was provided with a voltmeter suitable for both alternating and direct-current with a range of 150 to 600 volts, using a potential transformer for the 2,300-volt motors. The ammeter best suited is one used in connection with a split-core transformer. The chief advantage of this type of ammeter is that the reading can be multiplied any desirable number of times to give a large enough reading by merely passing the motor leads more than once through the transformer. Standard 40-deg. motors found to be operating at more than 10 per cent above the full-load current stamped on the nameplate were exchanged when possible for larger ones elsewhere in the plant. In like manner motors found less than 75 per cent loaded were exchanged where possible.

Previous to the use of this system it was the practice of taking for granted that everything was all right, and no load tests were run until a breakdown occurred. The results of the scheduled load testing have proved extremely worth while, as it has shown up dangerous overloads due to mistakes in selecting motors for the job, unbalanced voltage, low voltage, one phase open due to a blown fuse, worn bearings, loose rotor bars, and other faults. Previous to the use of the chart, invariably some out-of-the-way motors were neglected.

At the beginning a routine schedule system will appear superfluous and unnecessary, and certain parts may be, but these can be eliminated after a trial of the system. Written instructions are the foundation of the maintenance and test work. R. H. PARISH.

Mission, Texas.

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IN MANY PLANTS it is the practice to keep a complete record of particulars of all motors: location, date installed, size, type, repairs done, etc. Such an account furnishes useful information as to the best type of motor for different classes of work, the performance of different kinds of bearings, brushes, and other parts. The record is not complete, however, without particulars of the maximum and average loads on each motor.

Most motors of 150 hp. capacity and over have some form of indicating instrument permanently connected, as well as a watt-hour meter. There is no question as to the usefulness to the operator of such instruments. Anything abnormal, either in the machines driven or in the motor itself, will be indicated at once. On alternating-current circuits knowledge of power-factor values, gained from these meters, may be important.

For the smaller motors a portable ammeter is all that is necessary for making load tests. On direct-current circuits two or three different shunts should be available to insure a satisfactory reading on the ammeter. For alternating-current work a similar number of different-sized current transformers will give range enough to test small, medium-sized and large motors. There is now on the market a small alternating-current clip-on ammeter which is held in one hand while being used. This has a double range of 0 to 100 and 0 to 500 amp., and has been designed for rapid measuring of motor loads.

The length of the period between tests will naturally depend upon the nature of the load on the motors, but a test every six months should be satisfactory under conditions of steady load the year round.

The use of the meter reading is manifold. It shows if motors are overloaded or underloaded. The latter may have an important bearing on the power factor of an alternating-current circuit. It helps with the proper balancing of loads on different lines. It gives the starting and running currents. On two- or three-phase motors, if readings are taken on each phase they may show an out-of-balance load which would ultimately lead to breakdown, or even indicate a blown fuse on the running side of a lightly loaded motor. Any change from normal in the magnitude of the meter reading is a warning of impending trouble. E. SCOTT RIVETT.

Noranda, Que.

A Question for Our Readers

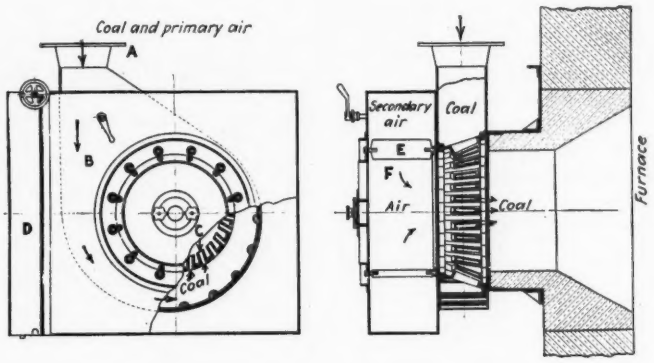
ON OUR power system the power factor is around 78 per cent. There is a possibility of replacing some of the larger induction motors with those of the synchronous type, but some doubt is expressed in our organization as to how much we should try to improve the power factor, if any. Will some of POWER'S *readers tell their experience with correcting the power factor of their power systems, the benefits derived and the methods used to bring about the improvement?* O. R.

Suitable answers from readers, if received promptly, will be paid for when published.

WHAT'S NEW IN PLANT EQUIPMENT

High-Capacity Pulverized-Coal Burner

ABILITY to burn sufficient coal to produce 135,000 lb. of steam per hour without reaching the upper limit of capacity is claimed for the Cyclone burner recently announced by the Riley Stoker Corporation, Worcester, Mass. This rate of steam generation from one



Riley cyclone burner with sufficient coal burning capacity to give a heat liberation rate about two hundred million B.t.u. per hour

burner represents heat liberation of over 205,000,000 B.t.u. per hour.

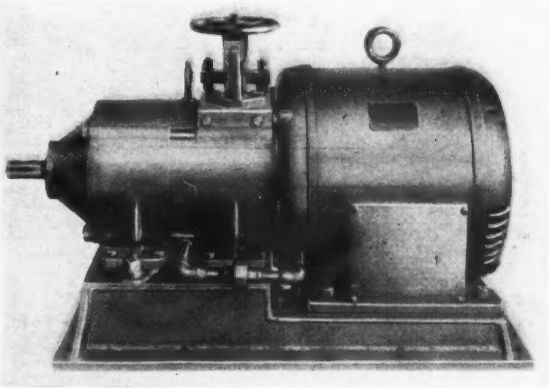
Referring to the illustration, flange *A* of the burner is connected to the coal discharge pipe from the pulverizer. Coal and primary air pass into the space *B* and out of ports *C*. Secondary air after passing through damper *D* goes through vanes *F*, thereby receiving a whirling motion. From here the secondary air passes into space *F* and into the furnace. Intense turbulence and positive mixing of coal and air are said to result from the whirling circular motion of the secondary air striking the multiple coal streams traveling in the line of the burner axis. The turbulence created tends to give high coal-burning rates with a comparatively short flame.

Electro-Hydraulic Transmission Gives Wide Range of Speeds

AN ELECTRO-HYDRAULIC TRANSMISSION, designed to develop full rated torque at any speed from 1 to 1,100 r.p.m., has been developed by the American Engineering Company, Philadelphia, Pa. In the transmission the torque is constant and the horsepower output varies with the speed of the hydraulic motor. At maximum speed the transmission is rated 5 hp. continuously.

In the illustration the hydraulic motor is at the left, hydraulic pump next to it in the middle, and electric motor at the right. They are all mounted on a single bedplate reservoir which contains the oil used in the system. The entire transmission, including motor, is only 30 in. long, 14 in. wide and 16 in. high.

The hydraulic pump and motor are of the Hele-Shaw design and are similar in construction except that the motor has a fixed stroke while the stroke of the pump may be varied from minimum to maximum. Pump and motor are multi-cylindered and are designed to handle the fluid in a smooth, continuous stream.



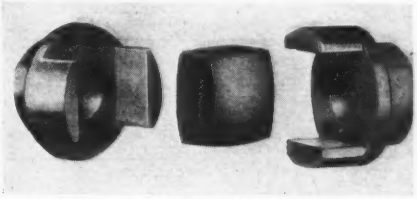
Transmission unit and motor are mounted on oil reservoir

The electric motor drives the pump shaft at a constant speed. Oil is delivered by the pump to the hydraulic motor at a rate corresponding to the stroke of the pump, regulated by the handwheel on the top of the unit (as shown) or other hand or automatic control. Through the handwheel the speed of the hydraulic motor can be varied all the way from zero to maximum in either a forward or reverse direction.

The oil is maintained at the proper working temperature by passing it through finned tubing over which air is blown by a fan mounted on the motor shaft at the pump end.

Small Flexible Couplings for Industrial Drives

A RECENT ADDITION to the line of flexible-shaft couplings, manufactured by the American Flexible Coupling Company, Erie, Pa., includes two small sizes with maximum bores of $\frac{3}{4}$ in. and 1 in. and designated No. 4 and No. 6, respectively. In general design and kinematic action the small couplings are



American flexible coupling

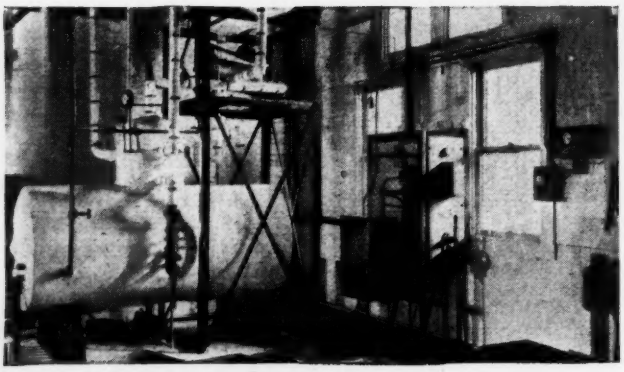
the same as the larger couplings manufactured by this company.

The flange sections of the small American couplings are die-cast. A wide groove is formed in the face, leaving two jaws between which the floating center member slides, as shown in the illustration. The floating center member is a solid, non-metallic, self-lubricating piece and transmits the torque between the flange sections. Both sizes permit a maximum parallel misalignment of $\frac{3}{64}$ in. and a maximum angular misalignment of 1 degree.

Small-Capacity Electric Steam Generators

A LINE of electric steam generators in two pressure ratings, 100 and 200 lb., in various sizes and electrical ratings has been introduced by the General Electric Company, Schenectady, N. Y.

The standard unit consists of a suitable steel container in which one or more immersion heaters (depending upon the capacity required) are inserted. The generator is provided with standard boiler fittings, including a safety valve, steam gage, water column, blowoff valve, steam valve, etc. A typical control equipment consists of a magnetic switch and an automatic pressure governor which, when operated in conjunction with a low-water alarm, automatic heat shutoff switch and some device for



Installation of electric steam generator complete with controls

automatically feeding additional water to the generator, makes the equipment automatic in operation.

The units are available with generator shells of numerous different standard sizes. Generator shells of the same dimensions but with different pressure ratings, 100 or 200 lb., can be furnished. Several different kilowatt input ratings are obtainable for any given generator. Three-heat switches can be furnished for each 5-kw. heater unit up to a rating of 15 kw., so that a variety of ratings may be obtained, from 1.25 to 15 kw. by increments of 1.25 kilowatts. The units are designed to operate on 115, 230 or 440 volts direct or alternating current.

Instrument for Determining Illumination Intensities

DETERMINATION of illumination intensities is the function of a new instrument known as Model 603 Illuminometer developed recently by the Weston Electrical Instrument Corporation, Newark, N. J.

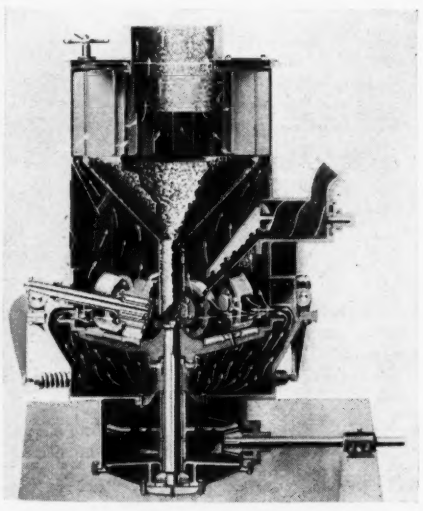
It consists of an indicating instrument and a light target assembled in a portable case. The light target is on the end of a flexible cord so that it may be placed in any position. This light target, or searching unit, has two Photronic cell units which convert light energy directly into electrical energy without the use of batteries or other auxiliary voltage. The output from the Photronic cell units is said to be considerable, allowing the use of a rugged, portable instrument calibrated directly in foot-candles.

There are three ranges on the instrument, namely, 10, 50 and 250 foot-candles. A range-changing switch is provided for selecting the desired scale. Other combinations of ranges are being added to the line and will be available shortly. Light may be read from all angles and the light target may be placed in relatively inaccessible places. The absorption of light by painted walls, screens, draperies, etc., can be measured directly by turning the light target so that it faces the surface.

Weston Model 603 Illuminometer

Improved Table-Roller Pulverizer

THE ILLUSTRATION shows the improved (Bethlehem) table-roller pulverizer now being manufactured by the Grindle Fuel Equipment Company, a subsidiary of the Whiting Corporation, Harvey, Ill. The principle of grinding originally employed is retained. The coal is fed to the center of a cone-shaped, slowly revolving table, from which point it is caused to move outward in a thin layer by centrifugal action. In moving across the slightly inclined surface of the table the coal is brought under the grinding action of a number of rollers, the pressure of the roliers upon the table being adjustable from the outside.



Pulverizer with improved grinding elements and system of lubrication

In the new unit, which has been completely redesigned, important changes have been in the design of the bearings, rollers and system of lubrication. Certain changes have been made in the design of the table, and one-piece tracks are now used in place of the segmental tracks originally employed. The labyrinth seal between the table and shaft bearing, directly below, has not only been simplified but has been made more effective for keeping dust out of the bearing. An independently driven screw-type feeder with variable-speed drive is now used for feeding the coal to the machine. The feeder drive is particularly suitable for regulation by automatic combustion control.

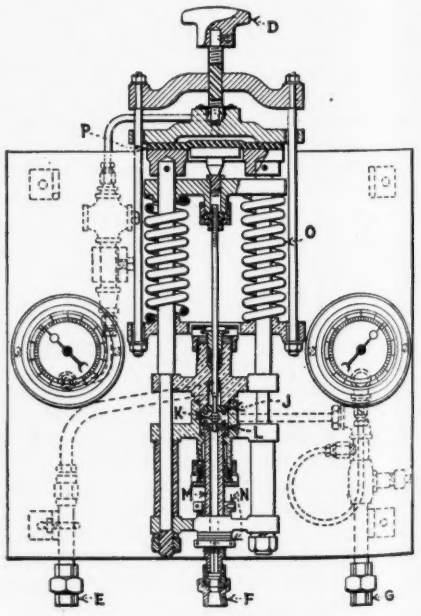
One of the claims made for the improved unit is that it can be operated over an unsually wide range of capacity. It is built in three sizes, No. 1A, No 2A and No. 3A, with corresponding capacities of 3, 7 and 12 tons of coal an hour.

Relay Pressure Valve

ONE OF THE latest developments of the Bailey Meter Company, Cleveland, Ohio, is a relay pressure valve known as the Style G, which is designed for pressure control of steam, water or gas lines.

Briefly, the relay valve controls the pressure within close limits by regulating the movement of a sylphon-operated or piston-operated throttle valve installed in the line in which the pressure is to be controlled.

The controlled pressure is connected to point *B* and serves to actuate the diaphragm against the force of springs *O*. A motive pressure of air, water or steam at 150 lb. gage or over is connected to line *F*. Line *G* connects to the sylphon or piston-operated regulating valve and line *E* serves as an exhaust. The pressure which exists in line *G* depends upon the position of the diamond valve *K* between port *L*, through which the motive pressure enters, and



Bailey Style G relay pressure valve

seat *J*, through which the pressure exhausts. Assuming that the pressure *B* increases above that for which the relay valve is set, valve *K* moves closer to the seat *L* by the movement of diaphragm *P*. This throttles the flow through seat *J*, with a consequent decrease in pressure in line *G*, which, in turn, causes the main regulating valve to close slightly and bring the control pressure back to normal. By changing the seat gap by adjustment of the micrometer adjusting nuts *M* and *N* it is possible to obtain any desired speed or lag in amplified pressure connection *G*. The valve can be used to operate a single valve or a series of valves or pistons.

Series Type Feed-Water Regulator

DESIGNED primarily for boilers operating with rapidly fluctuating loads and to control the water feed in accordance with the rate of steam flow, with compensation for changes in boiler water level, the Copes series-type regulator has been announced by Northern Equipment Company, Erie, Pa.

The regulator is actuated by two thermostats connected in series, one above the other, as shown in the illustration. The upper thermostat is influenced by the rate of steam flow in the main steam header; the lower by changes in boiler water level. Movement of either one will operate the control valve.

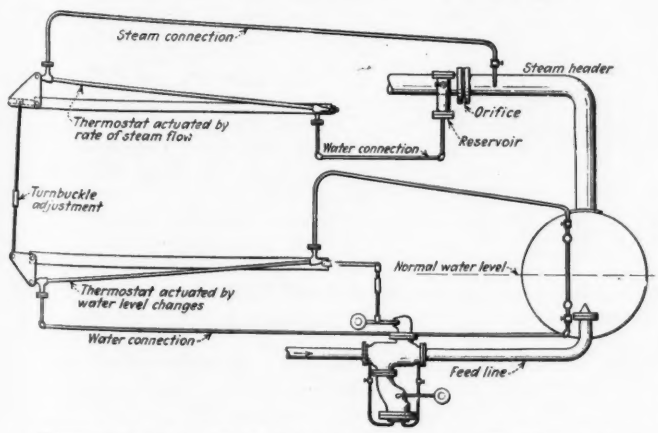
The upper or steam end of the steam-flow thermostat is connected to the main steam header. The lower, or water connection, is made to a reservoir connected to the steam header at the level of the upper end of the thermostat, and on the low-pressure side of the steam connection.

At no load the steam flow thermostat is filled with water. As the load increases, the difference in pressure between the two connections in the steam header forces the water level down. Steam enters the thermostat, expanding it and opening the feed valve. As the load decreases, the water level in the expansion tube rises, causing the tube to contract and close the feed valve.

If the water level in the boiler drum does not change, the entire valve movement is under the sole influence of the steam-flow thermostat. It is only when boiler water level changes that there is any influence from the level thermostat.

An adjustment is provided to permit increasing or decreasing the influence of the steam-flow thermostat. There is also an adjustment in the compensation of the level thermostat.

Through the design of the control valve fittings, it is possible to control the ratio of inflow to outflow. This ratio may be such that a high water level is carried at high loads and a low level at low loads, or at any stage between this and the exact reverse of low level at high loads and high level on low loads. A Copes Type RG combined feed-flow differential-pressure control valve is used with the regulator.



Copes series type feed-water regulator controlled by both steamflow and water level

New Sizes of Motorpump

A NUMBER of new sizes have been added to the Cameron line of small general-service centrifugal motorpumps which were illustrated and described in the June 30, 1931, number. These pumps are now made in one-inch discharge and upward.

Pump and motor are assembled as a single unit with a common shaft, producing a compact, light-weight pump which requires no foundation or baseplate. The discharge nozzle may be turned to any one of four positions. The impeller is made of bronze and is hydraulically balanced. Renewable bronze wearing rings and shaft sleeve are provided.

These pumps, which are put out by Ingersoll-Rand Company, 11 Broadway, New York City, are used against moderate heads for such services as in circulation systems, air conditioning equipment, standpipe and water-supply systems, condensate return and general transfer service handling a wide variety of liquids.

Power's pocket-size smoke meter

Smoke Comparator

SMOKE-ABATEMENT campaigns now being carried on throughout the country have necessitated firemen or stoker operators keeping a closer watch on the smoke emitted from their stacks than they would otherwise do except in the interest of economy.

With a view to providing a simple and practical means of determining readily the quality of smoke, *Power*, 330 West 42d St., New York City, has produced the pocket-size smoke meter or comparator illustrated.

The meter consists essentially of two celluloid disks $4\frac{1}{4}$ in. in diameter attached together at their centers so as to permit the rotation of one disk with relation to the other. The front disk of the meter is divided into five equal sectors as shown, each of which has a definite grade of color representing 20, 40, 60, 80 and 100 per cent of black, and numbered 1 to 5, respectively. The front disk is fitted with four slotted openings ($\frac{3}{16}$x$1\frac{1}{4}$ in.) centered on the four division lines as shown, while the rear disk, which is colored black, has only one opening of similar size and location with respect to the center of the disk.

The meter is held at a comfortable distance from the eye so that the light falling upon it is the same as that striking the smoke. Then the color of the smoke is observed by having the slot in the black disk in line with the eye and turning the front, or shaded, disk until the color of the smoke as seen through the slot matches with either of the adjacent colored sectors, which also indicates the corresponding Ringelmann chart number. The meter may be used by fireman, plant operators, smoke inspectors or anyone interested in the smoke problem.

This smoke meter is intended to supplement but not supersede the Ringelmann Standard Chart, upon which it is based.

NEWS of the FIELD

House Committee Studies Inconsistencies in Recent Report of Muscle Shoals Commission

MEMBERS of the Muscle Shoals Commission are being examined by the House Committee on Military Affairs in an effort to clear up certain inconsistencies which appear in the handsomely bound report of the commission, recently submitted to Congress by President Hoover.

The report, which contains a technical study of the fertilizer industry and an engineering survey of the Muscle Shoals plants, recommends private as opposed to governmental operation of the project and the leasing of the properties under a 50-year contract for the primary purpose of producing commercial fertilizer. It urges that preference in leasing be given to a non-profit making corporation owned and controlled by organizations of farmers. It further recommends construction of Cove Creek Dam by the government, and the sale of surplus power at the switchboard to Tennessee Valley interests, with preference for states, counties, municipalities and chemical operations. Revenue derived from the sale of power it proposes to use for research and fertilizer storage.

Representative Percy Quinn of Mississippi, chairman of the House committee, stated that the main purpose in examining members of the commission is to obtain greater information concerning the facts which lead up to the recommendations of the report. In particular, Mr. Quinn desires to clarify the status of the Muscle Shoals plant from the standpoint of fertilizer production. He would like to know what caused the commission to emphasize the fertilizer production possibilities of the project in face of the technical report obtained from the Department of Agriculture minimizing the potential value of the fertilizer facilities.

Another question arises over the proposed Cove Creek Dam. In recommending that the government proceed with the construction of the dam, the commission disagrees with the conclusions of the extensive engineering survey prepared by Lieutenant-Colonel M. C. Tyler, of the Army engineers. Regarding Cove Creek, Colonel Tyler concludes:

"The Cove Creek project will have the maximum power value only if operated in public-utility service. The power plant at Cove Creek must be practically shut down four months during the winter of each year in order to give the greatest service during the low-water months. The value of the Cove Creek project itself for power in the public-utility system is about $17,000,000, while the estimated cost is $34,143,000. The construction of this project at the present time can not be justified, as it shows a deficit of about $17,000,000.

"The construction of the Cove Creek project at the present time would delay the construction of the dams in the main river between Knoxville and Chattanooga, and therefore will delay the completion of the navigation project."

The commission, however, maintains that the government construction of the project is justified and recommended by the "benefits to accrue to navigation, flood control and incidental power development there and at points downstream." The commission declares the dam "would greatly enhance the value of Wilson Dam and greatly encourage the building of other high dams on the Tennessee River. The construction of Cove Creek Dam should be begun immediately after the disposition, by lease, or otherwise, of the Muscle Shoals project has been authorized."

Following examination of members of the commission, the House committee will hold public hearings in an effort to frame suitable legislation for the disposal of the Muscle Shoals properties.

BURNING WATER

Both water and fire discharge simultaneously from this 525-ft. well recently drilled to supply the plant of the Ferro Enamel Corporation, Cleveland. On placing the turbine pump in operation, it was found that the water in this well contained small bubbles of natural gas, quite high in B.t.u. content. The company estimates that three to four months of continuous pumping will be required to exhaust the gas, which, according to a geological survey, is a drift gas having no connection with the commercial deposit below the well

First 160,000-Kw. Unit in Operation at Hudson Ave.

THE FIRST of two 160,000-kw. tandem-compound turbine-generators installed in the Hudson Avenue station of the Brooklyn Edison Company has been placed in operation, it was announced Jan. 8 by President Matthew S. Sloan. Completion of both units will raise the total capacity of the station to 770,000 kw., making it the largest steam plant in the world.

Four boilers supply the new turbine with steam at 400 lb. pressure and 730 deg. F. temperature. The boilers are fired by the longest underfeed stokers ever manufactured, and each boiler has a capacity of 530,000 lb. of steam per hour. The turbine exhausts into the largest single-pass surface condenser, which has a condensing surface of 101,000 sq.ft. Rated at 200,000 kva., the generator has the largest 1,800-r.p.m. revolving field ever built, both as to size and capacity.

Pure Air Exhibit Held by N. Y. Academy of Medicine

AN EXHIBIT to promote cleanliness of air and streets was held last week at the New York Academy of Medicine in New York City. Arranged primarily for educational purposes, it stressed the prevention of air pollution through proper methods of street cleaning and the control of smoke, dust and other inpurities of city air which cause injury to health, death of plant life and economic loss through improper combustion as well as the destruction of fabrics, building materials and household effects.

The display consisted not only of

graphs, charts, photographs and various scientific instruments used in measuring contamination but also of models and pictures of street-cleaning apparatus, ventilating machines, stokers and moving pictures showing various phases of the subject. It included exhibits to illustrate the sources of air contamination, the nature of the harmful components in polluted air, the medical and economic aspects of such pollution, the results of research in this field and the known methods of preventing air contamination from various sources.

More than 50 organizations and individuals engaged in scientific, educational and commercial pursuits contributed over 100 units to the material displayed. As result of the interest it aroused in New York, the exhibit will be shown, in whole or part, in other localities throughout the country, which have requested to see it.

N. Y. Power Authority Urges Municipal Distribution Law

IN AN INTERIM REPORT to Governor Franklin D. Roosevelt, the New York State Power Authority urges the Legislature to pass laws permitting municipalities to sell electricity to their citizens and to householders in adjacent rural districts. Unless this alternative market for the power proposed to be developed by the state on the St. Lawrence River is provided, the Authority fears that it will be handicapped in negotiating a "fair" contract with the Niagara Hudson Power Corporation for the transmission and distribution of the power.

The Governor incorporated the Authority's recommendation in his annual message to the Legislature, reported last week in *Power*. The Authority's report was in his hands on Dec. 31, but was not made public until Jan. 11.

Although the Authority professed to see a need for legislation widening the market for public sale of the St. Lawrence power, it reported that progress in carrying out its mandate to undertake the hydro-electric development had been limited to conferences with the Federal government, the Canadian authorities and the power companies, none of which resulted in a definite understanding.

Work on 100,000-Kw. Project To Start Soon in Formosa

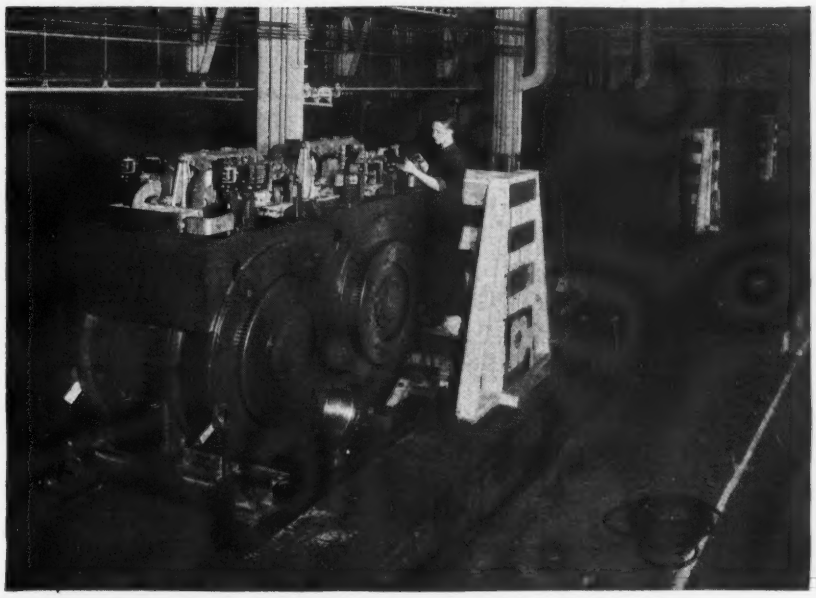
JITSUGETSUTAN hydro-electric project on the island of Taiwan (Formosa), Japan, which has been the subject of discussion for the past eleven years, seems about to become a reality, according to a report of Vice-Consul Hayward G. Hill in *Commerce Reports* for Jan. 4. Negotiations for a bond issue were successfully concluded in New York in June of last year, and construction contracts have been awarded to five Taiwan contractors and two contractors from Japan proper.

Briefly, the project calls for the construction of a 100,000-kw. hydro-electric plant, to be operated by the waters of Lake Jitsugetsutan. This lake, situated about the center of the island at an elevation of 2,400 ft., has a catchment area of approximately 6.55 sq.mi., and in the future will be fed by tapping the waters of the Dakusui-kei (Muddy Water River). Incidentially, Lake Jitsugetsutan is regarded as one of the most attractive and picturesque places in Taiwan, and its potential value as a resort will not be impaired by the completion of the hydro-electric project.

The plant will be the largest in the Far East, and the current to be generated will be used to supply the needs of all Taiwan. When demand warrants, another plant will be erected below the site of the present project; to it will be conducted the water utilized by the first unit. The rest of the work to be done on the initial development is expected to require about three years.

Although the original plans were for the project to be a government undertaking, it was finally decided to make it a joint activity of government and private interests. This led to the formation in 1919 of the Taiwan Electric Power Company, a limited liability company, the stock in which was acquired by both government and private interests; it is, therefore, quasi-official in nature. Under these auspices work was commenced in 1919. In 1922 financial difficulties caused activity to be suspended, and in December, 1926, the scheme was reported as abandoned.

FIRST MOTORS FOR P.R.R. ELECTRIFICATION



Nine specially developed a.c. motors, together with controls, made up the first consignment of $9,000,000 worth of electrical equipment for the Pennsylvania Railroad electrification between New York and Washington, which was recently shipped by the Westinghouse Electric & Manufacturing Company to the Baldwin Locomotive Works, builders of locomotives. Instead of the usual crating, the motors were protected while in transit with special large metal covers

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Utah Light Company Must Pay Idaho Power Tax, Court Rules

IN A DECISION handed down recently in the Idaho kilowatt-hour tax case, the Federal Court for the District of Idaho sitting at Boise ruled that the generation of power is akin to manufacture and precedes transmission, that it can be measured before it enters transmission, and therefore the tax does not interfere with interstate commerce.

The suit was brought by the Utah Power & Light Company, which has several power plants in the State of Idaho and serves consumers in that state. The company contended that the law passed by the Idaho legislature last year imposing a tax of ½ mill per kilowatt-hour on all electrical energy generated within the state, was unconstitutional because electrical energy could not be measured as, where and when produced, but that it went into commerce instantaneously and its use was its measurement. This contention was upheld by the testimony of scientists but, the court's opinion points out, "as usual among experts, there appears a difference of opinion relating to the practical and scientific view." The decision further stated that it had been established by the power company's own witnesses that the company had accurately measured the output at various generators.

Decision had previously been rendered that the law was constitutional in so far as state questions were concerned (*Power*, Sept. 1, p. 340), but the interstate phases of the situation had been given further consideration by the court.

Seventh 34,000-Hp. Unit Installed at Paugan, Que.

GATINEAU POWER COMPANY, a part of Canadian Hydro-Electric Corporation, has completed the installation of the seventh 34,000-hp. generator in its Paugan (Que.) hydro-electric plant. With the addition of this unit Paugan now has an installed capacity of 238,000 hp. and ranks as one of the largest hydro-electric generating stations in North America. As the Paugan power house can take care of eight 34,000-hp. generators, the installation of the present seventh unit involved only the cost of the machinery, resulting in comparatively low additional capital cost per horsepower.

The installation of the new unit at Paugan raises to 472,500 hp. the aggregate installed capacity of the company's plants on the Gatineau River, and increases to 575,119 hp. the interconnected capacity of all its stations on the Ottawa River, Gatineau River and other tributaries. In addition, the company has 104,400 hp. in other hydro-electric plants, making a grand total of 679,519 horsepower.

The new unit has a vertical-shaft, single francis-type runner, plate-steel casing turbine, operating on a net effective head of 132 ft. at 125 r.p.m. It is a duplicate of the present units with the exception of the runner and lower distributor ring which are somewhat larger and the draft tube which has been modified in order to give slightly higher efficiency. The generator of the new unit is rated at 28,500 kva., 85 per cent power factor, three-phase, 6,600 volts, 25 cycles, 125 r.p.m. It is a vertical type with direct-connected auxiliary generator rated at 300 kva. and a direct-connected pilot exciter rated at 21 kw. It is an exact duplicate of the other six generators in the plant.

Third Patent Exposition At Philadelphia, Feb. 1-10

BUSINESS MEN and manufacturers, representing every section of the country and every industry, will gather in Philadelphia, Pa., during Feb. 1 to 10, inclusive, to visit the Third International Patent Exposition, which will be held in that city's $6,000,000 convention hall.

The Exposition, of which Major-General George O. Squier, noted inventor, is honorary chairman, is expected to eclipse the splendid record of the second show, which was held in the Merchandise Mart in Chicago, last year.

Many thousands of models of new inventions, none of which has yet been placed on the market, will be on display. They range from the amusing to the amazing—from "Teacups to Television," from "A Needle to an Anchor." Inventors of some 25 nations will be represented at the exposition, including 445 women who will have approximately 700 models of their patents on display.

COMING CONVENTIONS

American Society of Mechanical Engineers. Spring meeting at Bigwin Inn, Lake of Bays, Ont., Canada, June 27-July 1. Oil and Gas Power meeting at Pennsylvania State College, June 8-11. Secretary, Calvin W. Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. Annual winter convention in New York City, Jan. 25-29. Secretary, F. L. Hutchinson, 33 West 39th St., New York.

American Boiler Manufacturers Association. Mid-winter meeting at the Hotel Cleveland, Cleveland, Ohio, Feb. 11. Annual convention at the Greenbrier Hotel, White Sulphur Springs, W. Va., May 23-25. Secretary, A. C. Baker, 801 Rockefeller Building, Cleveland, Ohio.

American Society of Civil Engineers. Annual meeting in New York City, Jan. 20-23. Secretary, George T. Seabury, 33 West 39th St., New York City.

American Society of Heating and Ventilating Engineers. Annual meeting and exposition, Hotel Statler, Cleveland, Ohio, Jan. 25-29. Secretary, A. V. Hutchinson, 51 Madison Ave., New York City.

American Society of Refrigerating Engineers. Joint meeting with the A.S.H.V.E. and annual convention at the Hotel Cleveland, Cleveland, Ohio, Jan. 26-29. Secretary, David L. Fiske, 37 West 39th St., New York City.

American Society for Testing Materials. Annual meeting at Chalfonte-Haddon Hall, Atlantic City, N. J., June 20-24. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Water Works Association. Annual convention at the Hotel Peabody, Memphis, Tenn., May 2-6. Secretary, Beekman C. Little, 29 West 39th St., New York City.

Engineering Institute of Canada. Annual meeting at the Royal York Hotel, Toronto, Ont., Feb. 3-5. Secretary, R. J. Durley, 2050 Mansfield St., Montreal, Que.

National District Heating Association. Annual convention at the William Penn Hotel, Pittsburgh, Pa., June 14-17. Secretary, D. L. Gaskill, Greenville, Ohio.

National Marine Engineers Beneficial Association. Annual convention at the Hotel Jefferson, St. Louis, Mo., Feb. 8-12. Secretary-Treasurer, Albert L. Jones, 313 Machinists' Building, Washington, D. C.

National Electric Light Association. Annual convention in the Atlantic City Auditorium and Convention Hall, Atlantic City, N. J., June 6-10. Secretary, A. Jackson Marshall, 420 Lexington Ave., New York City.

SECTION MEETINGS

A.S.M.E., Metroplitan Section. Meeting in Room 502, Engineering Societies Building, Jan. 28 at 8 p.m. Subjects: "An Outline of Problems in Utilizing Bunker C Oil With Special Emphasis on Oils Containing Cracked Residues From High-Pressure Stills," T. B. Stillman, and "Operating Experience in Using Bunker C Oil," E. S. Hammond.

A.S.M.E., Philadelphia Section. Technical session at the Engineers Club, Jan. 26 at 8 p.m. Subject: "Diesel Electric Power for Large Buildings," Edgar J. Kates.

A.S.M.E., Schenectady Section. Meeting in Edison Club Hall, Jan. 21 at 8 p.m. Subject: "Vertical Transportation," Bassett Jones.

A.I.&S.E.E., Philadelphia Section. Meeting in the Engineers' Club, Feb. 6 at 7 p.m. Subject: "Mercury-Arc Rectifiers for Steel-Mill and Industrial Applications," W. E. Gutzwiller and R. W. Davis.

Symposium on Steel Castings Feature of A.S.T.M. Meeting

A SYMPOSIUM on steel castings will be held at the annual meeting of the American Society for Testing Materials in Atlantic City. This symposium sponsored jointly by the American Foundrymen's Association and the A.S.T.M. is the second on the subject of castings sponsored by these two societies, the first having been held at the 1931 A.S.T.M. meeting and devoted to malleable iron castings. The purpose in sponsoring these symposiums on castings is to procure and publish authoritative critical data on their engineering properties—data of great value to all designers, producers and users of castings which are not now conveniently accessible in any one publication.

An imposing group of papers has been arranged for the symposium. The authors of the papers are well qualified to speak on their respective subjects from extensive contact with the casting industry. The plans for the program—not yet entirely completed—call for an introduction, a general survey of the steel casting industry and statistics covering steel castings which combined will give a general picture of the methods of producing steel castings, an idea of the economic importance of the industry and other data of a non-technical, but nevertheless important bearing in the steel castings industry.

The technical subjects will involve principles of design as related to physical properties; soundness and ease of production; problems in the heat-treatment and welding of steel castings; and test bar specifications including the relationship between physical properties obtained from coupons and the properties of the metal in the castings. One paper will give general data on steel castings and their fields of application governed by the physical properties.

Plan 30,000-Hp. Plant for Yakima Irrigation Project

ACCORDING TO PLANS revealed in Yakima, Wash., by W. L. Rowe, reclamation engineer, who is making a survey of the Yakima-Benton irrigation project, the outstanding feature will be the big power ditch, 101 miles in length, which will half-circle Yakima and the Roza irrigation canal. The power ditch, which will carry 3,000 sec-ft. of water, will be fed from the Yakima River, and will follow the course of the ditch and canal of the Moxee Canal Company. Approximately a mile and a half from the Yakima River at Union Gap, a power plant, with expected capacity of 30,000 hp. will be built. This plant is expected to help finance construction. East Selah and Moxee Valley acreage coming under the canal will be about 4,000, but beyond the valley approximately 66,000 acres will be irrigated.

Personals

HERBERT S. WHITON, who has been acting chief mechanical engineer of the Byllesby Engineering & Management Corporation, Chicago, since the retirement in March, 1930, of H. BOYD BRYDON, has been appointed officially to this position. Mr. Whiton joined the Byllesby organization in 1923 as assistant chief mechanical engineer. Prior to that he was superintendent of power for the Minneapolis General Electric Company.

SIDNEY HOSMER, IRVING E. MOULTROP and LEAVITT L. EDGAR, of the Edison Electric Illuminating Company of Boston, were recently advanced in position, following the retirement after 44 years' service of W. H. ATKINS, vice-president and general manager. Mr. Hosmer, who has been vice-president and head of the construction bureau, was made vice-president and assistant general manager; Mr. Edgar, formerly vice-president and assistant general superintendent, is now vice-president in charge of the operating bureau; and Mr. Moultrop, who is chief engineer, becomes also head of the construction bureau.

JOHN M. DONALDSON, chief engineer of the North Metropolitan Electric Power Supply Company, London, England, was recently elected president of the Institution of Electrical Engineers. Early in his career Mr. Donaldson engaged in engineering work in the United States and Canada.

G. B. WARREN has been appointed designing engineer of the steam turbine section and M. A. SAVAGE designing engineer of the steam turbine-generator section of the General Electric Company. J. H. DORAN has been appointed assistant on mechanical design for the turbine engineering department, and W. E. BLOWNEY administrative assistant in the same department.

Col. ELLIOTT H. WHITLOCK, head of the department of smoke research at Stevens Institute of Technology, has been placed in charge of the division of work and resources of the emergency relief administration, with headquarters at Newark, N. J. He will serve under CHESTER I. BERNARD on the state work for unemployment relief. Colonel Whitlock's services were donated by Dr. HARVEY N. DAVIS, president, as the Institute's contribution to the work.

FOUR ENGINEERS of the Westinghouse Electric & Manufacturing Company have been honored by invitations to present technical papers at the International Electrical Congress, to be held in Paris, France, in June, 1932. The men chosen are J. SLEPAIN, whose subject will be "Interruption of Power Arcs"; C. L. FORTESCUE, who will discuss "Lightning and its Effects"; and R. D. EVANS and C. WAGNER will cooperate in the preparation of a paper on "Stability of Power Systems."

How's Business?

THE YEAR has started with considerably more snap than was expected, though less than in '30 and '31, says *The Business Week*, Jan. 20. The first full week's records do not indicate any definite turn in industrial and business activity, but they show some response to seasonal stimulus in steel and the cotton trade, and at least resistance to further recession in almost all lines. Commodity prices continue encouragingly steady. Active interest in the auto show has aroused more optimistic estimates of spring output. Power production, carloadings, construction projects are still slack. The first half of January has been distinguished chiefly by pronounced improvement in securities markets, principally in rails and especially in bond prices.

Electric output of public utilities for the week ended Jan. 9 was 1,619,265,000 kw.-hr., or 5.5 per cent below the corresponding period of 1931, according to N.E.L.A. figures.

Business Notes

BABCOCK & WILCOX COMPANY, New York City, announces a further consolidation of its resources and facilities with those of the Fuller Lehigh Company. The sales offices of the two firms have been combined, and all business heretofore carried on separately or jointly by these companies will be done in the name of the Babcock & Wilcox Company through its district sales offices. An outgrowth of B. & W.'s purchase of Fuller Lehigh in 1926, this latest consolidation will, the company states, result in a more completely coordinated and efficient sales, engineering and manufacturing service to customers of both organizations.

FALK CORPORATION, Milwaukee, Wis., announces a lower schedule of prices on various types and sizes of speed reducers. These price changes apply to all sizes in common use.

INTERNATIONAL NICKEL COMPANY, New York City, announces that R. L. Suhl, for the past three years assistant to the late Frederick S. Jordan, succeeds him as manager of the nickel sales department. Ransom Cooper, Jr., Walter C. Kerrigan and Charles McKnight have been appointed as Mr. Suhl's assistants. In the development and research department, T. H. Wickenden, since 1922 in charge of the company's development work in the automotive and aeronautical fields, has been made assistant manager of development and research; and H. J. French, a member of the research staff at the Bayonne (N. J.) laboratory since 1929, has been transferred to the department to take charge of development work in steel and iron.

R. S. ERNST, representing the Northern Pump Company, Minneapolis, Minn., and the Hardie-Tynes Manufacturing Company, Birmingham, Ala., has moved his office to Room 1036, 520 North Michigan Ave., Chicago, Ill.

R. H. BACON, formerly advertising and publicity manager of Fairbanks, Morse & Company, Chicago, has established an industrial news service in that city, with offices at 201 North Wells Street.

Trade Catalogs

LUBRICATION — The Lunkenheimer Company, Cincinnati, Ohio, has just issued a new booklet which describes and illustrates its full line of oil cups and oiling devices.

INSTRUMENTS—Bulletin No. 192, just issued by the Bailey Meter Company, Cleveland, Ohio, describes and illustrates the theory and operation of gravity recorders for liquids. In addition, it explains how the Bailey automatic control system may be applied to maintain the specific gravity of a liquid.

MODELS—A new bulletin, filled with interesting illustrations of scale models for practically every purpose, has been issued by the H. E. Boucher Manufacturing Company, 150 Lafayette St., New York, N. Y. These models are used for commercial, educational, advertising, scientific and litigation purposes.

ANTI-FREEZE SYSTEM—Improvements in the design of Tanner tanks and control of "Tannergas," used to prevent freezing of compressed-air lines, are described and illustrated in Bulletin No. 100-C, recently issued by the Sullivan Machinery Company, 400 North Michigan Ave., Chicago, Ill.

TEMPERATURE CONTROL—A full, illustrated description of the construction and operation of the new Neilan non-recording temperature controller is contained in Bulletin No. 3060-B, just issued by the Neilan Company (Division of the Mason Regulator Company), 641-651 Santa Fe Ave., Los Angeles, Calif.

PUMPS AND DREDGES—Four new bulletins have been issued by the Morris Machine Works, Baldwinsville, N. Y., covering recent developments in their extensive line of dredges and centrifugal pumps. Bulletin 140 concisely outlines various types of centrifugal pumps, hydraulic dredge machinery and steam engines; Bulletin 141 describes small pumping plants for sand and gravel production; Bulletin 142 is devoted to medium-duty dredging pumps for heads up to 100 ft.; and Bulletin 143 features heavy-duty lined dredging pumps for severe services.

NEW PLANT CONSTRUCTION

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ala., Mobile—Treasury Department, Office of Supervising Architect, Washington, D. C., receiving bids for a group of buildings including extension and remodeling main hospital building, construction of nurses' quarters, boiler house, etc., at Marine Hospital here. Estimated cost $450,000.

Calif., Sunnyvale—Bureau of Yards & Docks, Navy Department, Washington, D. C., will receive bids until February 3 for construction of a group of buildings including boiler plant, helium building, medium pressure helium storage building, etc., at Naval Air station here.

Calif., Mare Island (sta. Vallejo)—Bureau of Yards & Docks, Navy Department, Washington, D. C., received lowest bid for construction of substation, battery overhaul building and acid mixing plant here from Barnett & Hilp, 918 Harrison St., San Francisco. $145,400.

Ill., Blue Island—City, G. J. Landgray, Clk., City Hall, plans construction of a power plant. Estimated cost $40,000. Allen L. Fox is city engineer.

Ia., Iowa City—Iowa State University, c/o State Board of Education, Des Moines, awarded contract for additional boiler unit, breeching and feed water regulator, superheater, soot blower, boiler setting and stoker for heating and power plant building. Total cost $34,200.

La., Morgan City—City is having plans prepared for construction of a power and water plant, electric transmission lines, and water distribution system. Swanson McGraw, Inc., Balter Bldg., New Orleans, are engineers.

Miss., Starkville—City awarded contract for complete construction of electric light plant and distribution system to Fairbanks Morse & Co., 1000 St. Charles St., New Orleans, $93,840.

Neb., Crete—Doane College plans development of general plant, including landscaping of lakes, small bridges, heating plant, etc.

N. J., Jersey City—Daniel J. Scrocco, 60 Park Pl., Newark, Archt., will receive bids about March 22 for construction of a 13 story office and stores building including steam heating and ventilating systems, boilers, elevators, etc., on Summit Ave. for Joseph Siegel Inc., c/o architect. Estimated cost $650,000.

N. Y., Honeywood—New York & Richmond Gas Co., 691 Bay St., St. George, S. I., having preliminary plans prepared for construction of an artificial gas plant here. Estimated cost $125,000. Private plans.

N. Y., Baldwin—Department of Water, Gas & Electricity, Municipal Bldg., New York, plans construction of wells with pumping equipment and other necessary work here to add 4,000,000 gal. daily to New York City water supply.

N. Y., Ossining—Department of Correction, State Office Bldg., Albany, awarded general contract for construction of power house and knit shop, tunnels, heating and electric connections and apparatus at Sing Sing Prison here to Louis Levine, 305 Broadway, New York, $393,600.

N. Y., Stapleton—U. S. Marine Hospital, 21 Bay St., preparing plans for construction of a hospital group involving main building, nurses' home, power house and laundry building, etc., at Tompkins, Vanderbilt and Bay Sts. Estimated cost $2,500,000. Kenneth M. Murchison and William H. Gompert, 101 Park Ave., New York, are architects. Tachan & Vought, 102 East 30th St., New York, N. Y., are associate architects.

O., Piqua—City did not take bids on January 6 for construction of a power plant, including turbine generator, surface condenser and steam generating unit consisting of boilers, exhaust fans, motors, Diesel engine, etc. Estimated cost $810,000. Burns & McDonnell Engineering Co., 406 Interstate Bldg., Kansas City, Mo., is engineer. Project held up by temporary court injunction.

Okla., Drumright—Stanolind Pipe Line Co., Phicade Bldg., Tulsa, awarded contract for a 66 x 78 ft. addition to pumping station here to DeWitt & Howard, Roberts Bldg., Drumright. Estimated cost $25,000.

Tex., Borger—I. J. Killion, has been granted franchise for improvements to electric light plant including erection of power unit, transmission lines, etc.

Va., Lexington — Washington and Lee University, plans removal of power plant to new site and reconstruction. Estimated cost to exceed $40,000.

Wash., Wapato—Bureau of Reclamation has ordered Dwight Redman, Engr., to prepare revised plans for construction of pumping unit No. 2 in connection with Wapato irrigation project. $360,000 has been appropriated.

Wash., Yakima—Bureau of Reclamation, W. L. Rowe, Engr., having surveys made of Yakima-Benton irrigation project. Plans include construction of a power ditch, 101 miles long which will half circle Yakima and Roza irrigation canal and will carry 3,000 sec.ft. of water; also plans power plant, 30,000 hp. capacity at Union Gap, 1½ mies from Yakima River.

Wis., Kewaunee—City, authorized bond issue for construction of an electric light plant including complete equipment. Estimated cost $40,000. Engineer not selected. James W. Cain, Clk.

Ont., Toronto—North American Life Assurance Co., 199 Bay St., awarded contract for construction of a 15 story office building to George A. Fuller Co. of Canada, 210 Dundas St. W. Estimated cost $1,500,000. Steam heating system, etc., will be installed.

Ont., Toronto—Toronto Hydro Electric System, 225 Yonge St., awarded contract for caissons and foundations for 9 story office building, including steam heating system, etc. Estimated cost $1,000,000. Owner's staff and Chapman & Oxley, Sterling Tower, are associate architects.

Ont., Windsor—Department of Public Works, Parliament Bldgs., Ottawa, plans construction of a 6 story post office building including steam heating system, etc. Estimated cost $1,000,000. C. E. Colthurst and J. E. Trace, Bank of Montreal Bldg., and Sheppard and Masson, 24 Chatham St. W., are associate architects.

Equipment Wanted

Boilers—Huntington, W. Va.—E. S. Engineer Office, War Dept., will receive bids until January 26 for one 200 or two 100 hp. Scotch marine boilers for dredge Col. M. B. Adams.

Motors—Palmer, Mass.—S. C. S. Box Co. Inc., plans to purchase motors 10 hp., variable speed, G. E., 500 v., 3 ph. (speed 550-1,600).

Motor—Toronto, Ont.—Jones & Moore Electrical Co. Ltd., 296 Adelaide St. W., plans to purchase a motor 2 hp., 25 cycle.

Pumping Equipment — Baltimore, Md. — Board of Awards, will receive bids until January 20 for furnishing and erecting pumping equipment for Pikesville automatic pumping station.

Pumps, Generating Units, Switchboard, etc.—Morgan City, La.—City plans to purchase two 1,000 g.p.m. underwriter motor driven pumps, two 350 g.p.m. domestic service motor driven pumps, one 1,000 g.p.m. and one 3,000 g.p.m. low head motor driven pumps, in connection with waterworks; also two 400 kw. oil engine generating units complete with all accessories, and switchboard for proposed power plant building.

Industrial Projects

Calif., Los Angeles — Chrysler Corp., 341 Massachusetts Ave., Detroit, Mich., plans construction of an assembly plant here. Estimated cost $2,000,000.

Ia., Dubuque—Maizewood Products Corp., C. E. Hartford, Local Mgr., Dubuque, and 203 North Wabash Ave., Chicago, Ill., plans to rebuild factory at Salina St. and Railroad Ave. destroyed by fire here. Estimated cost $100,000.

Mass., Peabody—Lampert Leather Co., Hancock St., plans reconstruction of factory destroyed by fire on Hancock St. Estimated cost $90,000. Architect not selected.

N. J., Carlstadt (br. Rutherford)—Plastic Art Marble Co., 321 11th St., awarded contract for construction of a 2 story factory on 14th St. to Kastner & Sons, 581 Broad St. Estimated cost $40,000.

N. J., East Rutherford—J. Thomas Camlet, 26 Piaget Ave., Clifton, Archt., will receive bids until February 23 for construction of a 2 story syringe factory at 54 Mozart St. here for East Rutherford Syringe Co., 75 Mozart St., East Rutherford. Estimated cost $50,000.

N. J., Newark—J. L. Hammett Co., 380 Jillife Ave., receiving bids for a 2 story addition to school supply factory. Estimated cost $40,000. Holden McLaughlin Associates, 670 5th Ave., New York, are architects.

Pa., Munhall—Carnegie Steel Corp., Carnegie Bldg., Pittsburgh, subsidiary of U. S. Steel Co., 71 Broadway, New York, plans additions to Homestead properties here. Estimated cost to exceed $40,000.

Tex., Odessa—Texas Potash Co., Republic Bank Bldg., Dallas, having surveys and test-hole explorations made for construction of a potash refining plant and mine unit in vicinity of Odessa. Estimated cost $2,000,000.

Tex., Overton—Gulf Refining Co., Comal St., San Antonio, plans construction of a casinghead gasoline plant here. Estimated cost $75,000. Private plans.

Tex., Willow Springs—Arkansas Fuel Oil Co., Shreveport, Ia., plans construction of a gasoline manufacturing plant, 80,000 gal. daily capacity here. Private plans.

Man., Winnipeg—Dominion Bridge Co., S. W. Campbell, Gen. Mgr., plans extension to plant. Private plans. Estimated cost $100,000.

Ont., Toronto—General Printing Ink Corp., 100 6th Ave., New York, N. Y., will establish a branch factory for the manufacture of its products at 179 John St., here. Perry D. Richards, c/o owner in charge of purchases of equipment to be installed in existing building which new plant will occupy.